MONTANA

CHAPTER 4

ENVIRONMENTAL CONSEQUENCES

CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

Introduction

This chapter presents the environmental impacts from management actions described in Chapter 2. The descriptions of predicted effects that would result from the exploration, construction, operation and maintenance, and abandonment activities associated with coal bed methane (CBM) for each alternative is compared to the pre-project environment.

Chapter 4 contains an *Introduction, Analysis Assumptions and Guidelines* section, and individual Resource Topic discussions. Table 2-3, in Chapter 2, summarizes and compares the impacts of the alternatives. The *Introduction* outlines the chapter and provides an explanation of the organization and creation of assumptions. The *Analysis Assumptions and Guidelines* section presents the Reasonably Foreseeable Development scenario (RFD) used to predict the level of CBM development and addresses the analysis assumptions common to all alternatives. The Resource Topic discussions are organized alphabetically. Under each resource topic, the following are addressed: assumptions, impacts from management common to all alternatives, and impacts from management specific to each alternative.

The duration of the impacts are analyzed and described as either short-term (up to 5 years) or long-term (greater than 5 years). Impacts from management of conventional oil and gas are found in the *Impacts From Management Common to All Alternatives* sections. Impacts from management of CBM are found in the *Impacts From Management Specific to Each Alternative* sections.

The narrative describing the impacts from management specific to each alternative includes subsections summarizing the impacts to the Crow and Northern Cheyenne Tribes, mitigation measures and a conclusions summary. The conclusion summarizes the cumulative impacts from other regional ongoing and foreseen projects.

Cumulative impacts consider the alternative in combination with other substantial existing and future developments in and near the CBM emphasis area, including oil and gas development projects, existing and future coal mines, new power plants, and effects from Wyoming's CBM development. Project descriptions for activities considered in the cumulative impacts analysis are presented in the Minerals Appendix under Oil and Gas. Mitigation measures that are not already included as part of the alternative or alternatives are described and evaluated, and the residual impacts are determined.

The resource discussions also address the differences between U.S. Bureau of Land Management (BLM) and State of Montana (state) impacts where divisions are meaningful. Physical impacts on landscapes from development disturbances can easily be quantified for BLM and state regulated wells; however, effects on watersheds or wildlife from both BLM and state development cannot easily be distinguished and therefore are discussed in conjunction.

Analysis Assumptions and Guidelines

Analysis assumptions and guidelines provide common data to environmental impact statement (EIS) team members to use when conducting the impact assessments for each resource. The assumptions and guidelines are based on previous events, experience of personnel, and their knowledge of the resources in the planning area. The assumptions include the demand for various resources, the ability of the resources to meet the demand, and how the actions will be carried out. An RFD was developed for this purpose and is discussed in the following sections.

Potential for Development—Reasonably Foreseeable Development Scenario

The RFD addresses potential development on all lands, including the Crow and Northern Cheyenne Indian reservations and the Ashland Ranger District of the U.S.

What has Changed in Chapter 4 Since the Draft EIS?

Chapter 4 describes the impacts of the alternatives in each of the resource areas. As described in Chapter 2, public comment on the Draft EIS resulted in additional mitigation measures for Alternative E—Preferred Alternative. These additional mitigation measures were evaluated by resource area specialists and the impact analysis was altered in some cases in this alternative. The Air Quality and Hydrology sections had additional changes, based on the improved data used, as text throughout the chapter was revised for simpler presentation. These changes were described in Chapter 3.

Forest Service (USFS). The RFD is in no way stating that the BLM or the State of Montana are making decisions for Indian lands or the USFS administered lands. For example, the decision to develop CBM on Indian lands will be made by the Indian allottees, and the tribes with concurrence of the Bureau of Indian Affairs (BIA), not by BLM or the state.

The presumption of possible impacts to the environment is based on BLM guidance (BLM H-1624-1) provided for estimating the potential for oil and gas resources and for extrapolating the degree of development that is reasonably foreseeable over a given period of time. In the case of Montana's Powder River Basin and additional areas of emphasis, it is the level of CBM development most likely to occur over the next 20-year period. The RFD is located in the Minerals Appendix, under "Reasonably Foreseeable Development Scenario." The following sections contain explanations of 1) the potential for CBM resources within the emphasis area boundaries, and 2) RFD for the different detailed development scenarios that are addressed by the various alternatives in this EIS.

Potential for CBM Resources

An estimate of CBM and conventional oil and gas resources was accomplished using many sources of information, including established files and databases, the BLM Resource Management Plans (RMPs) for the areas, coal information from the U.S. Geological Survey (USGS), professional and academic literature, available oil and gas maps, previous mineral assessments and expressions of interest, and projections from the oil and gas industry. To project CBM exploration and development, the areal extent of certain coals and the rank of coals in the CBM emphasis area were considered.

Areas of subbituminous to bituminous coals were considered as the most likely to be explored and developed in Montana, although exploration and development has occurred mainly in subbituminous coal in the Wyoming portion of the Powder River Basin. The USGS produced a Open File Report (OF 96-92) showing the areas of coal, by rank, for the United States. This information indicates subbituminous and bituminous coals in many parts of the emphasis area. See Map MIN-1 in the Minerals Appendix for an illustration of this data and Map 4-1 for a geographical presentation of potential CBM development within Montana.

Powder River, Rosebud, Custer, and Big Horn counties contain the northern part of the basin, which extends from Wyoming. Blaine and Musselshell counties have mostly subbituminous coal. Carbon County has an extension of the Big Horn Basin coal, which is ranked as bituminous coal. Gallatin and Park counties have scattered areas of bituminous to subbituminous coals.

The amount of methane gas that could be produced from the coal beds in Montana has been projected to range from a low of 1 trillion cubic feet (TCF) (Crockett and Meyer 2001) to a high of 17.7 TCF (Nelson 2000). This and other information for Montana is used to predict where CBM exploration is most likely to occur in the emphasis area. The RFD predicts the number of CBM wells that would be drilled and completed during the next 20 years per alternative. By making these predictions, cumulative impacts can be assessed.

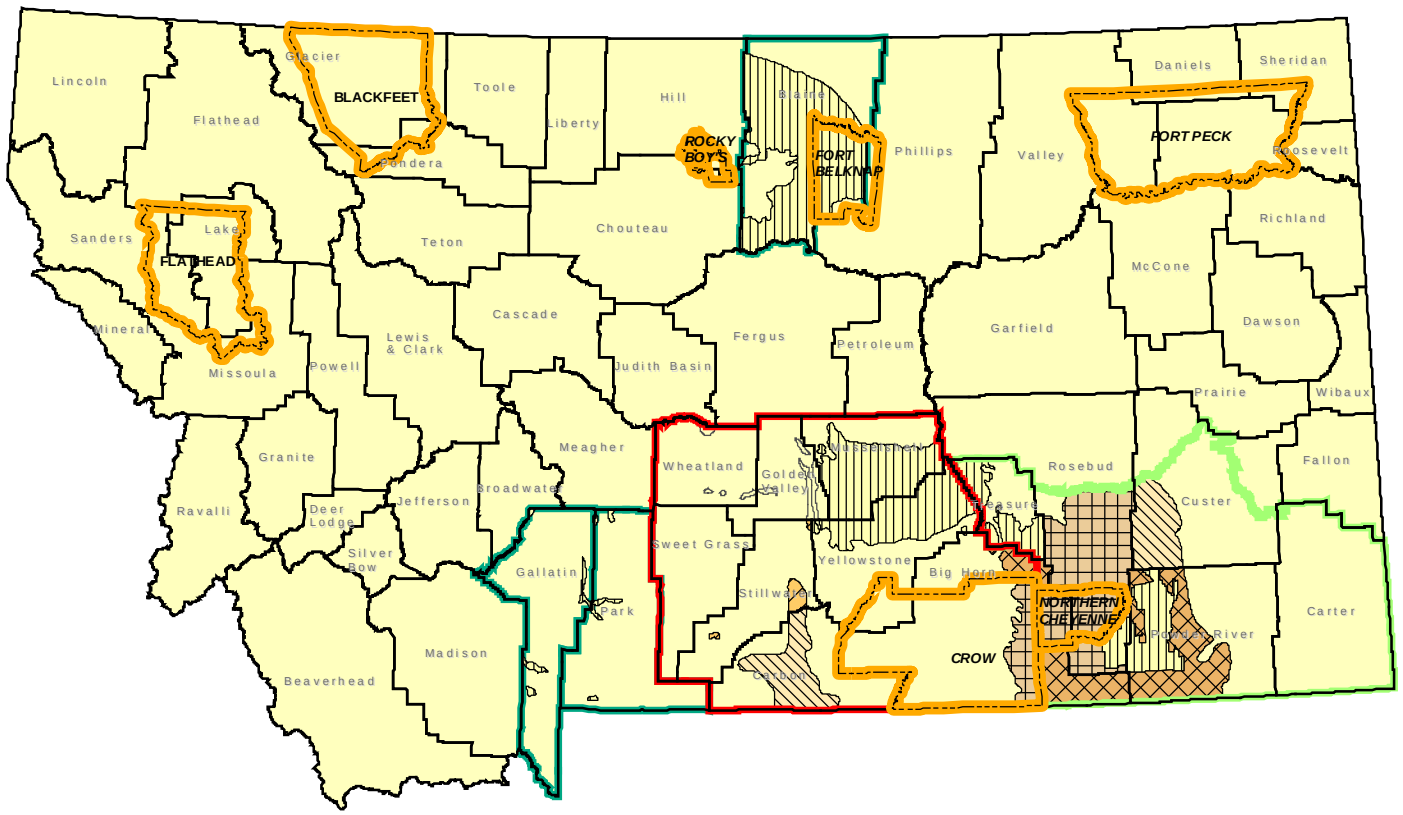
Reasonably Foreseeable Development Scenario

Projections of future CBM development and production are difficult to make. Several variables complicate such forecasts, including new exploration, development or production techniques; increases or decreases in demand for natural gas; and price increases or decreases that may prompt larger or smaller development and production programs. For this EIS, a combination of historical trends, present activity, government and industry estimates, and professional judgments were used in establishing the estimate of RFD. The RFD is discussed under two scenarios: restricted development and expanded development.

Restricted Development (Current Management)

Restricted development is applied to Alternative A. Under this scenario, the BLM would only approve exploration well permits and the state would only proceed with the development identified in the Stipulation and Settlement Agreement as presented in Chapter 2. With regards to the BLM exploration wells, an RFD of 200 wells per RMP area was assigned to provide a level of quantification for analysis; however, the BLM has no actual upper cap on issuing exploration well permits. The RFD number in no way represents a regulatory number for exploration wells that could be issued by the BLM. The 400 BLM exploration wells, combined with the state's limited development, results in a total of 675 exploration wells and 250 production wells assumed under Alternative A.

Map 4-1: CBM Development Based on Reasonably Foreseeable Development Scenario



Legend

POTENTIAL CBM WELLS

- Minimal
- 1 - 150
- 151 - 400
- 401 - 700
- 701 - 4000
- 4001 - 7000

- Powder River RMP Area
- Billings RMP Area
- Special Consideration Counties
- Native American Reservations

1:5,000,000

64,000 0 64,000 128,000 192,000 Meters

30 15 0 30 60 90 Miles

N W E S

This map shows the maximum number of CBM wells as described in the Reasonable Foreseeable Development Scenario. NOTE: Development on this map has been confined to the regions with known sub-bituminous coal occurences.

DATA SOURCES:

Counties: 1:100,000 scale, counties, Montana State Library/NRIS, Helena, Montana.
Reservations: 1:100,000 scale, counties, Montana State Library/NRIS, Helena, Montana.
Development Data: BLM Reasonable Foreseeable Development Scenario.

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Expanded Development

Expanded development is considered for Alternatives B, C, D, and E. Expanded refers to the number of potential wells based on known coal volumes that would be drilled in the CBM emphasis area during the next 20 years, regardless of mineral ownership. Given the current oil and gas stipulations, the restricted development areas, and the unknown geographical distribution of coal bed methane, it is unlikely that the maximum well density of 1 well per producing coal seam per 80 acres would be achieved. Map 4-1 indicates the predicted number of wells per county overlying known coal occurrences. The estimate for expanded development ranges from 10,000 to 26,000 wells drilled, the upper limit includes the Reasonably Foreseeable Future Action (RFFA) estimates of 4,000 wells each for the Crow and Northern Cheyenne reservations and 200 wells for the Custer National Forest. The Powder River RMP area could host as many as 7,500 to 14,000 producing CBM wells during the next 20 years. The RFD also estimated that between 200 to 800 new conventional oil and gas wells could be drilled in the Powder River RMP area during the same time period. In the Billings RMP area, an estimated 1,000 to 2,400 producing CBM wells could be installed. Conventional oil and gas wells are estimated to increase by 250 to 975 during this same time. The expanded estimate for the three counties outside the RMP areas suggested that from 18 to 50 CBM wells could be drilled (Blaine 3 to 10, Gallatin 5 to 15, and Park 10 to 25), along with 150 to 500 conventional oil and gas wells.

The expanded development estimate also predicted the number of potential field and sales compressors needed to export the gas. This level of development would require from 400 to 1,000 field compressors and from 50 to 100 sales compressors. Estimates for the gathering and sales lines are also included in the RFD.

Assumptions Common to All Alternatives

Assumptions common to all alternatives address issues such as level of disturbance associated with various development scenarios, implementation of best management practices (BMPs), general assumptions for percentages of alternative themes and numbers for various field equipment utilized, well spacing for production of CBM, and water discharge and drawdown rates for expanded development. These assumptions are used to ground the analysis so that similar comparisons can be conducted across the various resource topics and throughout the alternatives.

Levels of Disturbance

In evaluating environmental impacts, criteria for determining quantitative impacts are required. Further, to facilitate some uniformity with respect to impact analyses, the following synopsis was prepared to give a general understanding of the resources necessary for the installation and production of a single CBM well.

These values were determined from a variety of sources, including previous CBM Environmental Assessments, discussions with BLM and state personnel, discussions with CBM operators, and information derived from the review of numerous applicable documents. However, actual references are not provided as these numbers were ultimately derived through internal analysis based on understanding of current and proposed CBM activities in Montana and other areas (including Wyoming, Colorado, New Mexico, Arkansas, Alabama, and Oklahoma).

The values presented in Table 4-1 can be scaled to accommodate the various scenarios being proposed for exploration, construction and operation phases.

The following descriptions outline the assumptions used to develop Table 4-1.

Well Sites

Construction = 0.25 acre based on a 105-foot by 105-foot pad for exploration, construction and drilling operations

Operations = 0.058 acre based on a 50-foot by 50-foot pad for operations, well pad size may increase if multiple wells are drilled on the same pad, but total acres of disturbance would be less than separate well pads for single wells

Access Roads

Two-track = 0.30 acre based on 12-foot-wide roads by 0.21 mile/well (this applies to both construction and operation)

Graveled Roads = 0.11 acre based on 12-foot-wide roads by 0.075 mile/well (this applies to both construction and operation)

Bladed Roads = 0.075 acre based on 12-foot-wide roads by 0.05 mile/well (this is for construction phase only)

Bladed Roads = 0.090 acre based on 12-foot-wide roads by 0.06 mile/well (this is for operation phase only)

TABLE 4-1
LEVEL OF DISTURBANCE

Facilities		Exploratory Well Disturbance (acres/well)	Construction Disturbance (acres/well)	Operation/Production Disturbance (acres/well)
Well Sites		0.25	0.25	0.05
Access Roads/ Routes to Well Sites	Two-track	N/A	0.30	0.30
	Graveled	N/A	0.10	0.10
	Bladed	0.75	0.075	0.10
Utility Lines	Water	N/A	0.35	----[1]
	Overhead Elec.	N/A	0.20	0.20
	Underground Elec.	N/A	0.35	----
Transportation Lines	Low Pres. Gas	N/A	0.90	----
	Intermediate Pres. Gas	N/A	0.25	----
Processing Area	Battery Site	N/A	0.020	0.020
	Access Roads	N/A	0.15	0.15
	Field Compressor	N/A	----	(0.5/24) = 0.02
	1/24 producing wells			
	Sales Compressor	N/A	----	(1.0/240) = 0.005
	1/10 Field Compressors			
	[2]Plastic Line	N/A	----	0.5
	Gathering Line	N/A	----	0.25
	Sales Line	N/A	----	0.075
Produced Water Management	Discharge Point	N/A	0.01	0.002
	Storage Impoundment	N/A	0.3	0.25
Total Disturbance		1.0	3.25	2.0

Note: This table shows levels of disturbance associated with exploration and development of CBM wells and field transfer equipment. All values represent acres per well unless otherwise noted.

[1]All utilities are completed underground and the land above is reclaimed so the acres of disturbance are removed from the operation column. **Note:** The intent of reclamation is to stabilize the area of disturbance and establish a vegetative cover similar to the native plant community that existed prior to disturbance. Reclamation success will vary as described in the *Vegetation* section.

[2]Lines within processing area are assumed to disturb an average width of 25 feet.

Bladed Roads = 0.75 acre based on 12-foot-wide roads by 0.5 mile/well (this is for exploration only)

Utility Lines

Water = 0.35 acre based on 15-foot by 0.20 mile/well (construction only)

Elec. Utility Overhead = 0.20 acre based on 10-foot by 0.15 mile/well (construction and operation)

Elec. Utility Underground = 0.35 acre based on 15-foot by 0.20 mile/well (construction only)

Transportation Lines

Low Pressure Gas = 0.90 acre based on 15-foot by 0.5 mile/well (construction only)

Intermediate Pressure Gas = 0.25 acre based on 25-foot by 0.08 mile/well (construction only)

Battery Site

Construction and Operation = 0.5 acre per battery site. Assume one battery site per field compressor. Disturbance per well = (0.5/24) = 0.020

Access Roads = 0.15 acre based on 25-foot by 0.050 mile/ well during construction and operations

Field Compressors = 1 compressor/24 producing wells

Sales Compressors = 1 compressor/240 producing wells or 10 field compressors

Plastic line = 0.5 mile/well pad. Assume 3 wells per pad, 25-foot width

Gathering line = 2.0 miles/field compressor at 25-foot width or (5280*2*25/24/43,560) = 0.25 acre/well

Sales line = 6.0 miles/sales compressor at 25-foot wide. (6*5280*25/240/43,560) = 0.075 acre/well

Produced Water Management

Assume 1 discharge point for every 20 wells

Discharge points construction = 0.01 acre/point based on 20-foot by 20-foot area during construction

Discharge points operations = 0.002 acre/point based on 10-foot by 10-foot area during operations

Storage impoundments = 6 acres/impoundment during construction per well pod of 20 wells, assume one acre reclaimed from construction so 5 acres/impoundment during operation per pod of 20 wells

The actual disturbance per well will be dependent on the actual site specific water management practices used.

Total Area of Disturbance

Exploration = 1.0 acres/well

Construction = 3.25 acres/well

Operation = 2.0 acres/well

Field Rules and Leasing Stipulations

The discussion of impacts assumes that the leasing stipulations described for each resource would be successfully implemented in each of the alternatives regardless of land ownership or management classes to which they apply. Existing Lease Stipulations and mitigation measures (see Minerals Appendix, Table MIN-5) are considered to be standard operating procedures by BLM. The Montana Board of Oil and Gas Conservation (MBOGC) implements restrictions analogous to stipulations through the issuance of field rules. Field rules are applied on a case-by-case basis to protect resources on state land and private land. The MBOGC reviews each operator's development plan and then issues field rules.

The MBOGC will provide guidance to private landowners if requested on how and what to include in their leases to protect resources, but it is up to the individual lessor as to what they request from the operator in terms of reclamation, mitigation, and other measures. The Montana Trust Land Management Division (TLMD) of the Montana Department of Natural Resources and Conservation (DNRC) also has lease stipulations for their minerals as listed in the Minerals Appendix. The TLMD utilizes a set of standard stipulations on all oil and gas leases that is different from those used by BLM. Additional stipulations are placed on the leases on a case-by-case basis prior to their being leased. In addition, the TLMD undertakes a site-specific review process for exploration and operating plan proposals. This review process generates site-specific stipulations for issues such as steep topography, wildlife, streams, wooded areas, and rivers and lakes. It was assumed that only requirements contained in existing federal and state law that apply to private land ownership will be enforced on private land.

Stipulations and field rules are intended to avoid potential effects on resource values and land uses from oil and gas activities and include actions such as site clearances and occupancy and timing restrictions.

Lease stipulations would be implemented before conducting exploration, production, and abandonment activities. The following discussion of project impacts assumes that applicable stipulations and field rules would be fully implemented and followed. The success of these stipulations or field rules in avoiding covered impacts, in some instances, will require collection of site specific information regarding the resources to be protected relative to exploration, production, and abandonment plans followed by strict adherence to the terms of the stipulations and field rules. Planned monitoring activities by the BLM for all resources have been outlined in a table attached in the Monitoring Appendix. Impacts described include those that would occur in spite of the successful implementation of stipulations or field rules, or where stipulations or field rules are not expected to avoid all impacts.

Proposed mitigation measures are intended to minimize the impacts that cannot be avoided. Mitigation measures also apply to all alternatives on BLM and state lands. Residual impacts are those expected to remain after the implementation of mitigation measures.

General Assumptions

Assumptions represent the best professional judgment of the specialist based on experience, similar occurrences and known circumstances, and studies. Assumptions that are common to all of the alternatives provide the foundation for the analysis of impacts. The following assumptions apply to each alternative:

- The spacing for CBM wells would be similar to CBM well spacing in Wyoming with one well per 80 acres per coal seam. Up to three coal seams have been identified for possible methane extraction in the Powder River Basin. This would result in three wells drilled per 80-acre spacing unit.
- The life of a typical CBM production well is assumed to be 20 years.
- CBM wells will come on line and go off line as described in the RFD.
- Water production for a single CBM well can be estimated by the following equation:

  $$Q = 14661e^{-0.0242t}$$

  Where Q = discharge in gpm and t = time in months. The average production over 20 years using this equation is 2.5 gpm, however discharge rates would begin at approximately 15 gpm and decrease over time as the coal seam becomes dewatered.
- The combination of the 2 preceding assumptions results in the maximum discharge for the total field occurring in year 6 of the development, when 7,095 well would be pumping at an average rate of 6.2 gpm to produce 43,989 gpm. This maximum produced water volume is used for the impact analysis.
- 20% of waters discharged water will evaporate or infiltrate prior to perennial waters being impacted.
- It is assumed that a single CBM well will drain the methane from a single coal seam over an 80-acre unit. Research by the BLM in the Wyoming portion of the Powder River Basin suggests that drainage may be across a broader radius (Crockett and Meyer 2001). Drainage issues will need to be assessed on a case-by-case basis to determine the drainage radius, which will depend upon local reservoir parameters.
- The level of disturbance associated with a production well is the same regardless of the method of completion, whether a single well bore per coal seam or multiple seam completions in a well bore.
- Typical drilling operations for each CBM well, regardless of whether it was a CBM exploration or production well, would require 3 to 5 days with an additional 2 to 3 days for completion work. A maximum of 7 to 8 people would be present on a well at any one time during this construction phase.
- Approximately 26,000 gallons of water would be needed to drill each well. The water will be obtained from the local river, streams, wells, or reservoirs trucked into remote sites as needed.
- Equipment present at each well site during construction would consist of the following: one or two truck-mounted drill rig(s), with three men per rig; one backhoe; one blade; three crew pick-up trucks; one well logging truck; one pipe truck; two to four water trucks; one cement truck; one electrical generator trailer; one frac tank for wastewater; and two large flat bed trailers. Not all vehicles would be at the well site at the same time or for the entire duration of drilling and completion operations.
- Portable toilets would be available at the drill sites. Garbage would be stored in closed containers.

Sewage and solid waste would be hauled offsite to permitted disposal facilities.

- Each CBM well would be equipped with a submersible pump ranging from 3 to 20 horsepower, depending on well depth and other site conditions.
- Exploration wells would be visited once a day during testing and pumping operations. Pump tests could last as long as 6 months depending on the time required for measuring cumulative methane production estimates. Methane would be flared (burned off) continuously during the testing phase.
- Fuel for generators during exploration testing would be either gas (propane) or diesel and require at least one trip to the well site weekly. Small generators used during testing would be mobile, enclosed, and between 15 to 20 kilowatts (kW).
- A larger generator used during production would serve several wells (three to four) and be in the range of 75 to 125 kW.
- The proposed preferred alternative (Alternative 2A) for the Wyoming Powder River Basin oil and gas projects will be implemented under all alternatives. This alternative assumes continued development of CBM and conventional oil and gas resources would occur in the Wyoming Powder River Basin planning area. Up to 39,367 additional CBM wells and 3,200 conventional oil and gas wells would be developed over the next 10 years.
- Under Alternatives B, C, and D, the number of exploration/dry holes would be approximately 10 percent of the total estimated wells drilled. Furthermore, all exploration/dry holes would be drilled in the first 5 years of development.
- Under Alternatives A and C, the number of wells connected to each compressor would be per operators plans; it is assumed that this is consistent with the RFD of 24 wells per compressor. This estimate is based on an average well production rate of 250,000 cubic feet per day methane being sent to a 6 million cubic feet per day, four-stage reciprocal compressor operating at 380 horsepower and using natural gas.
- Under Alternatives B and D, the number of wells connected to each compressor would be maximized; this is assumed to be approximately 35 wells at average production going to a 9 million cubic feet per day, four-stage reciprocal compressor. The maximization of well connections would reduce the number of field compressor sites and air emissions.
- No hydraulic fracturing or cavitation would be required to stimulate wells; however, low-pressure, low-volume water enhancement may be used. This would involve flushing the well with a few hundred gallons of water to clean the face of coal surface in the exposed seam. This process does not fracture the coal; it simply cleans out the existing fractures.
- Under Alternatives B and D in the theme of CBM, multiple completions in a single borehole would be required. It is assumed that a small reduction in surface disturbance would be experienced, but that the levels of disturbance previously described are acceptable for these alternatives without alteration.
- Under Lands and Realty, when no transportation corridors are required, it is assumed that the utility lines (power, water, and gas) would be placed along separate routes, or in existing disturbances to and from the well site locations or compressor batteries, whichever is more suitable to the operator. When transportation corridors are required, it is assumed that they would be placed adjacent to access roads and along existing disturbances, resulting in a 35 percent reduction of disturbed surface areas.
- Concerning Socioeconomics it is assumed that the state would not enforce buffer zones on their minerals or on private minerals since they do not have a trust responsibility.
- The potential development on the reservations would be considered under the cumulative effects analysis based on the development outline in the RFD for the reservations.
- Under the Hydrology theme for Alternative B, untreated CBM water from exploration wells would be placed in tanks and disposed of at a permitted injection well. It is assumed that the use of pits, impoundments, and other holding facilities as permitted under Alternative A would be allowed. In addition, it is assumed produced water would be injected into a deeper aquifer of lesser quality with no communication to aquifers used as sources of drinking water or into coal seam aquifers.
- Under the Hydrology theme for Alternatives C and D, produced water would be available for beneficial use. It is assumed that industries and landowners would use approximately 20 percent of the produced water. The estimate of 20 percent is

based on the observed beneficial uses at the CX Ranch, and in Wyoming and on the perceived potential for similar uses throughout the emphasis area.

On August 23, 2002, U.S. District Judge Sam E. Haddon ruled that unaltered ground water discharged as a result of coal bed methane development is not a "pollutant" as that term is defined in the federal Clean Water Act (CWA). Since the court found that unaltered ground water is not a pollutant under the CWA, the court went on to hold that discharges from coal bed methane development do not require permits under the federal NPDES permit program (*Northern Plains Resource Council v. Redstone Gas Partners,* CV 00-105-BLG-SHE, District of Montana, Billings Division). In its ruling, the court explained that its holding applied with equal force to Montana's MPDES permit requirements. This decision is currently being appealed.

In response to this ruling, the DEQ is in the process of developing rules that, if approved by the Board of Environmental Review, would require proposed discharges from coal bed methane development to be reviewed by the DEQ to ensure compliance with state water quality standards. The rules would clarify DEQ's authority to impose limits or conditions on discharges of coal bed methane to ensure that all water quality standards, including the state's nondegradation requirements, will be met.

Through this process the anticipated impacts to surface waters from CBM activities would be similar if the Haddon decision is upheld or if CBM discharges are subject to permitting under the MPDES program. For the sake of analysis it is assumed in this document that CBM discharges are subject to MPDES requirements, however if this is not the case, the anticipated impacts would be similar, but the permitting process would change.

Assumption Rationale

CBM Well Production Life

The rationale for using a 20-year lifespan for a typical CBM well in Montana is based on several technical considerations as well as the best professional judgment of several specialists. The well life is based on the economic limit selected for the well, the wide variety of geologic basins in Montana, the data limitations, the variations in the rank of coals that may be encountered in Montana, and a review of the well life of CBM wells in other producing basins, including Wyoming and the San Juan Basin. These rationale are generally summarized below:

Montana Planning Area: The planning area for the Montana document is the Billings and Powder River RMPs for BLM and statewide with emphasis on the BLM planning area, plus Blaine, Park, and Gallatin counties for the state. Although an emphasis was placed on the Powder River Basin, assumptions used were derived for the entire planning area based on existing available information. CBM production in Montana and Wyoming is relatively new as compared to conventional oil and gas production in either of these states. In Montana, only approximately 250 producing CBM wells exist in a very small area near Decker, Montana. Throughout Montana, very little information is available relative to CBM production or testing outside of the current producing area at CX Ranch. Further, there are a variety of underground coal seams that must be considered, including areas in the Powder River Basin, Bull Mountain Basin, Park County, Gallatin County, Blaine County, and areas elsewhere in the state (including the entirety of the two BLM RMPs).

1. **Economic Production Limits on CBM Wells**: The BLM in Wyoming selected an average production life for CBM wells in the planning area based on production decline analysis from existing production on federal leases. These analyses assume an economic limit of approximately 1,000 MCF per month (personal communication, Bob Chase, BLM). CBM producers currently operating in the Wyoming Powder River Basin suggested the economic limit of 1,000 MCF per month to the BLM. Based on Wyoming's limited planning area and the extent of existing data available that is directly within the planning area, this approach appears justified. To date, no wells have been confirmed as reaching their economic limit in the Powder River Basin in either Wyoming or Montana. Several wells have reached monthly production of less than 1,000 MCF per month and several other wells have been shut-in. However, based on existing knowledge of CBM operations, it is not clear whether shut-in wells will remain shut-in without further production.

   The economic limits used by the Wyoming BLM of 1,000 MCF per month appear reasonable for planning in the Wyoming portion of the basin. However, there are many examples of wells producing at rates of less than 1,000 MCF per month for considerable periods. The Wyoming portion of the Powder River Basin has production rates less than 1,000 MCF while continuing to produce. However, it is currently unknown whether CBM wells in the Montana Powder River Basin will be shut-in and plugged once a

production rate of 1,000 MCF per month is achieved.

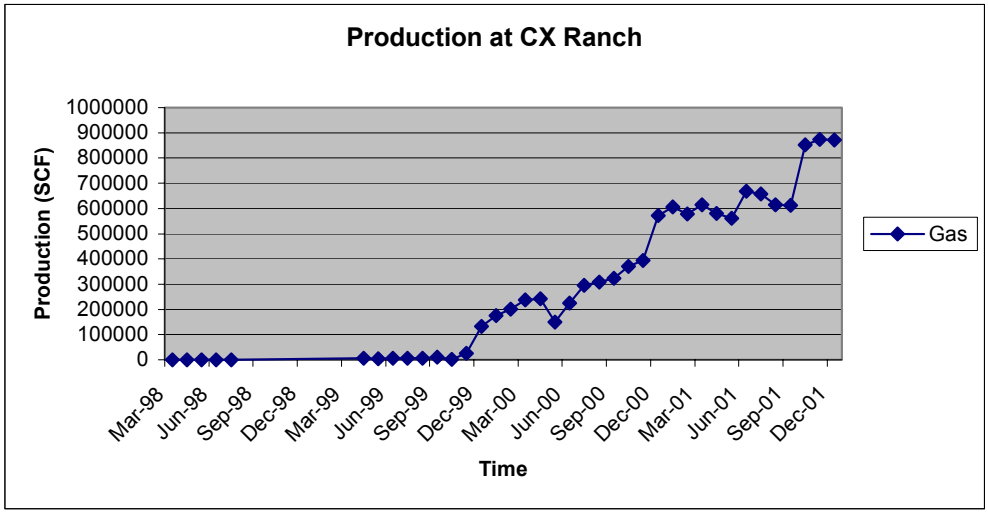
Of further consideration is the rationale that the proposed economic production limit used in the Wyoming EIS is based on certain economics provided by operators currently producing in Wyoming. Many of these producers are relatively large businesses. In the case of conventional oil and gas production, it is common for larger producers to sell production to smaller companies that may be capable of operating projects at a lesser cost—especially later in the life of the project when production rates are substantially reduced. This progression of producing properties transitioning from large companies to smaller companies supports the argument that the viable economic production life of a CBM well could be less than 1,000 MCF per month. This is especially significant considering the socioeconomic situation in Montana and especially relative to the Northern Cheyenne and Crow Indian reservations.

2. **Geologic Differences**: Because the Montana planning area includes the entire state, there are significant differences in geology when comparing assumptions used for impact analyses between the two plans.

3. **Data Limitations**: CBM production in Montana and Wyoming is relatively new as compared to conventional oil and gas production in either of these states. In Montana, only approximately 250 producing CBM wells exist in a very small area near Decker, Montana. Throughout Montana, very little information is available relative to CBM production or testing outside of one current producing area at CX Ranch. Further, there are a variety of underground coal seams that must be considered, including areas in the Powder River Basin, Bull Mountain Basin, Park County, Gallatin County, Blaine County, and areas elsewhere in the state (including the entirety of the two BLM RMPs). Figure 4-1 presents production data for the CX Ranch field near Decker, Montana (MBOGC 2001b). This figure shows that actual production of CBM in Montana started in April 1999.

4. **Variations in Rank of Coal**: Coals in the Powder River Basin are all of Tertiary age throughout both Montana and Wyoming. However, the Montana planning area includes coals that are much older and of higher rank. For instance, the coal seams near Bozeman Pass and Great Falls are of Cretaceous age and have an overall higher rank than Powder River Basin coals. This suggests that these coals may contain methane that is more thermogenic in nature than biogenic. Although there is not any existing production data for areas other than the CX Ranch in Montana, it is reasonable to assume that CBM wells in these areas may produce economic quantities of methane for longer durations than in the Powder River Basin without the benefit of historical production data. In certain situations, where multiple coal beds are present, a well's productive life can be extended by reworking the well to produce gas from deeper coal beds. For example, well completions in multiple coal beds could extend the life of a well site by 10 to 30 years.

FIGURE 4- 1
PRODUCTION AT THE CX RANCH



Studies of CBM wells in the San Juan Basin, which produce from greater depths than CBM wells in the PRB, have projected CBM gas production for 20 years. The deeper coal in other basins of Montana may produce in a similar fashion and have a well life of 20 years.

Differences in Produced Water Sodium Absorption Rate (SAR) and Electrical Conductivity (EC) Values

These differences are based on differences that exist across the basin. These differences are based on geologic and the available produced water data for each state. The geologic differences relate to how the coal seams change northward across the basin. In Wyoming, the coals seams are thicker (averaging up to 250 feet or more in aggregate thickness in many areas) and more continuous, northward in the basin into Montana, the coal seams thin (generally less than 100 aggregate feet) and become locally discontinuous.

In Montana there is a limited data set with little to no data outside the CX Ranch, which was used as the basis for the SAR and EC values in the DEIS. The produced water data available for the Montana Powder River Basin indicates there are significant differences in water quality in the northern part of the basin in comparison to the Wyoming portion of the Powder River Basin. The water quality data available for Montana varies enough from Wyoming that using the Wyoming data for impact analysis in Montana would underestimate the potential impacts in Montana.

Maximum Drawdown in Coal-Seam Aquifers

The Montana Bureau of Mines and Geology (Wheaton and Metesh 2002) released a report on the potential groundwater drawdown and recovery in the Montana portion of the Powder River Basin. The results of this report indicate that drawdown within the coal seams could be as high as 240 to 600 feet within the well field. The report also indicated drawdown as high as 300 feet in the interburden units, and 6 feet in the overburden units. The results of the model showed drawdown up to 30 feet at a distance of approximately 2 miles from the well field and drawdown of 5 feet at a distance of approximately 7 miles. The results of this model have been used to update the impact analysis in the Final Environmental Impact Statement (FEIS).

Decrease Flow in Surface Water

In the Montana portion of the Powder River Basin, the bulk of the coals of the Fort Union Formation are confined to the Tongue River Member, while the Lebo and Tullock Members are predominantly shale and shaley sand (McLellan et al. 1990). Because of the confined nature of the coals and lack of the Wasatch Formation in Montana, the production of CBM water is not expected to result in decreases to surface water base flows. There are also several potential increases to flow that may mask any potential decreases in surface water flow. The discharge of CBM-produced water to the ground surface and surface waters would mask any reduction in flow in the surface waters.

Beneficial Use of CBM Production Water

The Montana EIS preparation team assumes that 20 percent of the produced water will be available for beneficial purposes in Alternatives C and D. Under the Preferred CBM Development Alternative (E) it is assumed that emphasizing beneficial uses combined with increased flexibility for water management practices should result in an increase in beneficial water usage. The beneficial uses envisioned are based on current practices, such as livestock watering, creation of wildlife watering areas (Environmental News Network 2001), coal mine dust suppression (Fidelity 2001), irrigation, constructed wetlands (Davis 1995), domestic water supply, produced water as drilling fluid (Clark and Hemler 1992), de-icing of road aggregate storage piles (DeWalle and Geleone 1990), and enhancement of fisheries and riparian zones (Wyoming Game and Fish Department, n.d.).

Wyoming RFD Impacts

The Montana EIS accounts for the full scale of development proposed by the current Wyoming RFD. The introduction to Chapter 4 directs the reader to review the cumulative impacts discussion in the Minerals Appendix for effects from the CBM development in Wyoming. In the Minerals Appendix an expanded discussion regarding both the Wyodak RFD of 6,000 wells and the current Wyoming RFD with a proposed new 39,400 wells is addressed. Furthermore, within the *Hydrology* section of Chapter 4 under the *Conclusions for Alternative A* the effects of the expanded Wyoming RFD is acknowledged and accounted for in the impact analysis. These conclusions are also referenced under the other alternatives conclusion sections for cumulative impacts because they address the full range of possible impacts from Wyoming CBM development.

Resource Topics

Air Quality and Climate

Air Quality

Existing air quality throughout most of the analysis area is in attainment with all ambient air quality standards. However, three areas have been designated as federal nonattainment areas where the applicable standards have been violated in the past: Lame Deer (PM_{10}—moderate) and Laurel (SO_2—primary), Montana; and Sheridan, Wyoming (PM_{10}—moderate).

Impacts based on modeling show potential impacts only that would be mitigated through project level permitting.

Alternative A
No Action (Existing CBM Management)

- Localized short-term increases in CO, NO_x, SO_2, $PM_{2.5}$ and PM_{10} concentrations.
- Maximum concentrations would be below applicable state and National Ambient Air Quality Standards and PSD increments for near-field and far-field modeling.
- Potential direct impact on visibility within one mandatory federal PSD Class I, one Class II Area and the Class II Crow IR.
- Cumulative Impacts:
  - Potentially exceed the 24-hour PM_{10} NAAQS and PSD Class II increments south of Spring Creek Mine.
  - Potentially exceed PSD Class I increments for 24-hour PM_{10} on the Northern Cheyenne Reservation.
  - Potentially exceed atmospheric deposition thresholds in the very sensitive Upper Frozen Lake in the PSD Class I Bridger Wilderness Area.
  - Potential visibility impacts in 10 of 17 federal PSD Class I including the Crow and Fort Peck Indian Reservations. Additional visibility impacts to 7 of 13 PSD Class II sensitive areas including the Crow and Fort Belknap Indian Reservations.

Alternative B
CBM Development with Emphasis on Soil, Water, Air, Vegetation, Wildlife and Cultural Resources

- Localized short-term increases in CO, NO_x, SO_2, $PM_{2.5}$ and PM_{10} concentrations.
- Maximum concentrations are expected to be below applicable state and NAAQS and PSD increments for near-field and far-field modeling.
- Potential direct visibility impacts within seven mandatory federal PSD Class I Areas and the Northern Cheyenne Reservation. Additional visibility impacts to seven federal PSD Class II areas including the Crow and Fort Belknap Indian Reservations and three Wilderness Areas and one National Recreation Area and one National Monument.
- Cumulative Impacts:
  - Potentially exceed the 24-hour PM_{10} and $PM_{2.5}$ NAAQS south of Spring Creek Mine.
  - Potentially exceed the PSD Class II increments for 24-hour PM_{10} south of Spring Creek Mine.
  - Potentially exceed PSD Class I increments for 24-hour PM_{10} on the Northern Cheyenne Reservation and Washakie WSA.
  - Potentially exceed PSD Class I increments for annual NO_2 on the Northern Cheyenne Reservation.
  - Potentially exceed atmospheric deposition thresholds in the very sensitive Upper Frozen Lake in the PSD Class I Bridger Wilderness Area and Florence Lake in the Class II Cloud Peak Wilderness Area.
  - Potential visibility impacts in all federal PSD Class I and II sensitive areas including the N. Cheyenne, Fort Peck, Fort Belknap and Crow Indian Reservations.

Alternative C
Emphasize CBM Development

- Impacts under Alternative C are expected to be comparable to those describe for Alternative B but somewhat increased in severity due to the lack of control over operators choose for compressor fuel, reduced limits on compressor hook ups and the lack of enforceable control measures.

Alternative D
Encourage CBM Exploration and Development While Maintaining Existing Land Uses

- Localized short-term increases in CO, NO_x, SO_2, $PM_{2.5}$ and PM_{10} concentrations.
- Maximum concentrations are expected to be below applicable state and NAAQS and PSD increments for near-field and far-field modeling.
- Potential direct visibility impacts within one mandatory federal PSD Class I Areas. Additional visibility impacts to three PSD Class II areas including the Crow Indian Reservation, one Wilderness Area and one National Recreation Area.
- Cumulative Impacts:
  - Potentially exceed the 24-hour PM_{10} and $PM_{2.5}$ NAAQS south of Spring Creek Mine.
  - Potentially exceed the PSD Class II increments for 24-hour PM_{10} south of Spring Creek Mine.
  - Potentially exceed PSD Class I increments for 24-hour PM_{10} on the Northern Cheyenne Reservation and Washakie WSA.
  - Potentially exceed atmospheric deposition thresholds in the very sensitive Upper Frozen Lake in the PSD Class I Bridger Wilderness Area.
  - Potential visibility impacts in 14 of 17 federal PSD Class I and all Class II sensitive areas including the N. Cheyenne, Fort Peck, Fort Belknap and Crow Indian Reservations.

Alternative E
Preferred CBM Development Alternative

- Impacts modeled for Alternative E would be comparable to those describe for Alternative B but are somewhat decreased in severity due to the use of gas-fired compressors and maximized compressor hook ups.
- Although the air quality modeling shows the potential for certain standards to be exceeded, these impacts would not occur. The air quality permitting process would be used to analyze emission sources at the project level. Emission sources that would violate standards would not be permitted by the agencies and therefore, residual impacts would remain within standards.

Although the CBM development (project sources) and non-project sources emit carbon dioxide and methane, climate impacts are anticipated to be small from implementation of any of the alternatives. Climate impacts may even be beneficial to the extent that:

- Development of the CBM resource reduces the natural emissions of methane from coal mines
- Use of CBM displaces combustion of coal or oil, both of which emit more carbon dioxide than methane per unit energy produced.

Potential impacts to air quality are summarized in this section. A more complete summary of the modeled potential air quality impacts are given in the Air Quality Modeling Appendix with a highly detailed description of the air quality modeling given in Argonne 2002.

Issues, Impact Types, and Criteria

Fugitive dust and exhaust from construction activities, along with air pollutants emitted during operation (i.e., well operations, field and sales compressor engines, etc.), are potential causes of air quality impacts. These issues are more likely to generate public concern where natural gas development activities occur near residential areas. The Federal Land Managers (FLM), including the U.S. Department of Agriculture (USDA), U.S. Forest Service (USFS); the U.S. Department of Interior (USDI), National Park Service (NPS); and the USDI, U.S. Fish & Wildlife Service (FWS), have also expressed concerns regarding potential atmospheric deposition (acid rain) and visibility impacts within PSD Class I and PSD Class II areas under their administration, located throughout Montana, Wyoming, southwestern North Dakota, western South Dakota, northwestern Nebraska, and southeastern Idaho.

Air pollution impacts are limited by local, state, tribal and federal air quality regulations, standards, and implementation plans established under the Clean Air Act (CAA) and administered by the Montana Department of Environmental Quality—Air and Waste Management Bureau (MDEQ) and the EPA. Although not applicable to the proposed Alternatives, the Wyoming Department of Environmental Quality—Air Quality Division (WYDEQ) has similar jurisdiction over potential air pollutant emission sources in Wyoming, which can have a cumulative impact with MDEQ approved sources. Air quality regulations require certain proposed new, or modified existing, air pollutant emission sources (including CBM compression facilities) to undergo a permitting review before their construction can begin. Therefore, the applicable air quality regulatory agencies have the primary authority and responsibility to review permit applications and to require emission permits, fees and control devices, prior to construction and/or operation.

In addition, the U.S. Congress (through the CAA Section 116) authorized local, state, and tribal air quality regulatory agencies to establish air pollution control requirements more (but not less) stringent than federal requirements. Site-specific air quality analysis would be performed, and additional emission control measures, including a best available control technology (BACT) analysis and determination, may be required by the applicable air quality regulatory agencies to ensure protection of air quality resources. Also, under the Federal Land Policy and Management Act (FLPMA) and the CAA, BLM cannot (and would not) authorize any activity that does not conform to all applicable local, state, tribal, and federal air quality laws, regulations, standards, and implementation plans.

The significance criteria for potential air quality impacts include local, state, tribal, and federally enforced legal requirements to ensure air pollutant concentrations would remain within specific allowable levels. These requirements include the National and Montana Ambient Air Quality Standards, which set maximum limits for several air pollutants, and PSD increments, which limit the incremental increase of NO_2, SO_2, and PM_{10} concentrations above legally defined baseline levels. These legal limits were presented in Chapter 3. Where legal limits have not been established, the BLM uses the best available scientific information to identify thresholds of significant adverse impacts. Thresholds have been identified for hazardous air pollutant (HAP) exposure, potential atmospheric deposition impacts to sensitive lake water chemistry, and a "just noticeable change" in potential visibility impacts.

An extensive air quality modeling technical support document was prepared by Argonne National Laboratory (Argonne 2002), and is summarized in the Air Quality Modeling Appendix. This technical report is available for review (contact information is given in the Air Quality Appendix). Argonne modeled potential changes in air quality from individual Alternatives A, B, C, D, and E, non-project emission sources, and all sources cumulatively by alternative. Since Alternatives B, C, and E have similar emission inventories, a single air quality analysis represents all three alternatives.

The air quality modeling was based on the best available engineering data and assumptions, meteorology data, and dispersion modeling procedures, as well as professional and scientific judgment.

Due to the broad nature of this analysis, it should be considered a reasonable estimate of predicted impacts. Actual impacts at the time of project level development (subject to air pollutant emission source permitting) are likely to be less.

The EPA CALPUFF dispersion model was used with meteorological data generated by the MM5 (mesoscale model) and CALMET models. Meteorological information was assembled to characterize atmospheric transport and dispersion from several 1996 data sources, including the following:

1) 36 km gridded MM5 (mesoscale model) values with continuous four-dimensional data assimilation

2) Hourly surface observations (wind speed, wind direction, temperature, cloud cover, ceiling height, surface pressure, relative humidity, and precipitation)

3) Twice-daily upper air vertical profiles (wind speed, wind direction, temperature, and pressure)

4) PRISM-adjusted hourly precipitation measurements

Potential air pollutant emissions from the alternatives' emission sources (denoted as project sources) were calculated separately to determine potential impacts. These emissions were then combined with existing sources, proposed non-Powder River Basin Oil and Gas developments, and reasonably foreseeable future actions (RFFA) emissions (denoted as "non-project" sources), and RFFA emissions from potential CBM development on the Northern Cheyenne and Crow Indian Reservations and the Ashland District of the Custer National Forest to determine the total potential cumulative air quality impacts. All of the tables in this analysis and the Air Quality Modeling Appendix display modeled emmissions from the following:

1) The project sources only

2) The project sources combined with emissions from potential CBM development on the Northern Cheyenne and Crow Indian Reservations and the Ashland District of the Custer National Forest (denoted as "Project + RFFA Sources)

3) The non-project sources

4) Cumulative totals

The non-project sources include development permitted by the following agencies and states: 1) MDEQ; 2) WYDEQ; and 3) within the states of North Dakota, South Dakota, and Nebraska; and projections for the Wyoming Powder River Basin Oil and Gas Project DEIS Alternative sources (BLM 2002a); and other RFFA sources from states within the geographic area covered by the model.

Table 4-2 shows total emissions from the non-project (permitted and other RFFA sources), Wyoming Powder River Basin Oil and Gas project sources, and Montana Powder River Basin Oil and Gas project sources combined with RFFA sources. (Note that these emissions are for Alternatives B, C, and E; Alternative A and D emissions would be lower and the potential CBM wells on the Northern Cheyenne and Crow Indian Reservations and the Ashland District of the Custer National Forest have been included with the emissions for Alternatives B, C, and E.)

The meteorology data and air pollutant emission values were combined to predict maximum potential direct, indirect, and cumulative near-field air quality impacts in the vicinity of assumed well and compressor engine emission sources for comparison with applicable air quality standards and PSD Class II increments. Maximum potential near-field particulate matter emissions from traffic on unpaved roads and during well pad and compressor station construction were used to predict the maximum annual and 24-hour average SO_2, $PM_{2.5}$, and PM_{10} impacts. Maximum air pollutant emissions from each CBM well would be temporary (i.e., occurring during a 12-day construction period) and would occur in isolation, without significantly interacting with adjacent well locations. Particulate matter emissions from well pad, compressor station and resource road construction would be minimized by application of water and/or chemical dust suppressants. The control efficiency of these dust suppressants was computed at 50 percent during construction. During well completion testing, natural gas could be burned (flared) on a single day.

Air pollutant dispersion modeling was also performed to quantify potential PM (particulate matter), CO, NO_2, and HAP impacts during operation. Operation emissions would primarily occur due to increased compression requirements, including field and sales compressor stations. Since produced natural gas is nearly pure methane and ethane, with little or no liquid hydrocarbons, direct VOC emissions are not likely. HAP impacts were predicted based on an assumed, six-unit, 1,650-horsepower each, reciprocating compressor engine station operating at full load with emissions generated by a single stack.

TABLE 4-2
NON-PROJECT AND PROJECT TOTAL EMISSIONS SUMMARY

Source Category	Annual Emissions (tons/year)					
	NO_x	SO_2	PM_{10}	$PM_{2.5}$	CO	VOCs
Non-Project Sources (2006)						
DM&E Sources	14,391	3,655	722	263	799	294
CDWII Sources	1,269	563	257	---	---	---
Wyoming Sources	7,250	1,773	2,691	1,028	13,505	2,795
Montana Sources	3,169	950	2,279	1,003	2,576	880
Nebraska & N. Dakota Sources	1,114	26	102	48	449	132
New Sources Subtotal	27,192	6,966	6,051	2,343	17,329	4,101
Montana RFFA Sources	2,844	4,796	127	71	6,171	20
Wyoming RFFA Sources	1,578	3,381	298	155	3,381	--
South Dakota RFFA Sources	289	35	53	53	175	71
Other RFFA Sources Subtotal	4,710	8,212	478	279	9,277	91
Wyoming Alternative 1 Project Sources (w/Project Year noted)	**17,834** (Yr 5)	**829** (Yr 3)	**2,918** (Yr 6)	**1,280** (Yr 5)	**14,799** (Yr 5)	**8,268** (Yr 5)
Total Non-Project Sources	**49,737**	**16,007**	**9,447**	**3,902**	**41,855**	**12.460**
Montana Alt. B, C, and E Project + RFFA Sources (w/Project Year noted)	**9,959** (Yr 18)	**339** (Yr 5)	**1,230** (Yr 5)	**514** (Yr 15)	**9,378** (Yr 20)	**4,841** (Yr 20)

DM&E – Dakota, Minnesota and Eastern Railway Corporation

CDWII – Continental Divide/Wamsutter II and South Baggs Natural Gas Development Projects

The EPA CALPUFF dispersion model was also used to determine maximum far-field ambient air quality impacts at downwind mandatory federal PSD Class I areas, and other sensitive receptors, to accomplish the following:

1) Determine if the PSD Class I increments might be exceeded

2) Calculate potential total sulfur and nitrogen deposition, and their related potential impacts to sensitive lakes

3) Predict potential visibility impacts (regional haze) within distant sensitive receptors

The NEPA analysis compares potential air quality impacts from the proposed alternatives to applicable ambient air quality standards and PSD increments, but comparisons to the PSD Class I and II increments are intended to evaluate a threshold of concern for potential impacts, and do not represent a regulatory PSD Increment Consumption Analysis. Even though most of the development activities would occur within areas designated PSD Class II, the potential impacts on regional Class I areas are to be evaluated. The Montana DEQ will perform the required regulatory PSD increment analysis during the new sources review process. This formal regulatory process will include analysis of impacts on Class I and II air quality areas by existing and proposed emission sources. The activities are not allowed to cause incremental effects greater than the stringent Class I thresholds to occur inside any PSD Class I Area. Stringent emission controls (BACT – Best Available Control Technology) and emission limits may be stipulated in air quality permits as a result of this review, or a permit could be denied.

Several lakes within five USFS-designated wilderness areas were identified as being sensitive to atmospheric deposition and for which the most recent and complete data have been collected. The USFS (Fox et al, 1989) has identified the following total deposition (wet plus dry) thresholds below which no adverse impacts to air-quality related values (AQRVs) are likely: 5 kilograms per hectare per year (kg/ha-yr) for sulfur, and 3 kg/ha-yr for nitrogen. The USFS Rocky Mountain Region has also developed a screening method (USFS 2000) which identifies the following Limit of Acceptable Change regarding potential changes in lake chemistry: no more than a 10 percent change in acid neutralizing capacity (ANC) for those water bodies where the existing ANC is at or above 25 microequivalents per liter (μeq/l) and no more than a 1 μeq/l change for those extremely sensitive water bodies where the existing ANC is below 25 μeq/l. No sensitive lakes were identified by either the NPS or FWS.

Since the proposed Alternative and cumulative air pollutant emission sources constitute many small sources spread out over a very large area, discrete visible plumes are not likely to impact the distant sensitive areas, but the potential for cumulative visibility impacts (increased regional haze) is a concern. Regional haze degradation is caused by fine particles and gases scattering and absorbing light.

Potential changes to regional haze are calculated in terms of number of days with greater than a perceptible "just noticeable change" (1.0 deciview, or dv) in visibility when compared to background conditions. A 1.0 dv change is considered potentially significant in mandatory federal PSD Class I areas as described in the EPA Regional Haze Regulations (40 CFR 51.300 *et seq.*), and originally presented in Pitchford and Malm (1994). A 1.0 dv change is defined as about a 10 percent change in the extinction coefficient (corresponding) to a 2 to 5 percent change in contrast, for a black target against a clear sky, at the most optically sensitive distance from an observer). This is a small but noticeable change in haziness under most circumstances when viewing scenes in mandatory federal Class I areas. However, the perceptibility threshold can be smaller or larger than this value depending on viewing conditions.

For example, a 1.0 dv change is not a "just noticeable change" in all cases for all scenes. Visibility changes less than 1.0 dv are likely to be perceptible in some cases, especially where the scene being viewed is highly sensitive to small amounts of pollution, such as a site with preferential forward light scattering. Under other view-specific conditions, such as where the sight path to a scenic feature is less than the maximum visual range, a change greater than 1.0 dv might be required to be a "just noticeable change."

This NEPA analysis is not designed to be a regulatory analysis conducted to Federal Land Manager specifications nor is the analysis designed to predict specific visibility impacts for specific views in specific mandatory federal PSD Class I areas based on specific project designs. Rather, it is to characterize reasonably foreseeable visibility conditions that are representative of a fairly broad geographic region, based on multiple assumptions regarding project and non-project source emissions. This approach is consistent with both the nature of regional haze and the requirements of NEPA. The modeling was conducted to identify areas that may require more detailed consideration when specific project-level permits are issued for CBM development. At the time of a preconstruction air quality permit application, the applicable air quality regulatory agency may require a much more detailed visibility impact analysis. Factors such as the magnitude of dv change, frequency, time of the year, and the meteorological conditions during times when predicted visibility impacts are above the 1.0 dv threshold should all be considered when identifying areas for scrutinizing at the project-permitting level.

The USFS, NPS, and FWS have published their Final FLAG Phase I Report (Federal Register, Vol. 66 No. 2, dated January 3, 2001), providing a consistent and predictable process for assessing the impacts of new and existing sources on AQRVs including visibility. For example, the FLAG report states, "A cumulative effects analysis of new growth (defined as all PSD increment-consuming sources) on visibility impairment should be performed," and further, "If the visibility impairment from the proposed action, in combination with cumulative new source growth, is less than a change in extinction of 10 percent [1.0 dv] for all time periods, the FLMs will not likely object to the proposed action."

Air Quality Modeling Assumptions: Near-field impacts refer to receptor points less than 50 km from the emissions source; far-field impacts are greater than 50 km from the source. When reviewing the modeled near- and far-field results, it is important to understand the assumptions made regarding potential resource development. In developing this analysis, there is uncertainty regarding ultimate development (i.e., number of wells, equipment to be used, specific locations) and so actual impacts may vary from the modeled values and would be affected by project permit conditions or stipulations. The modeling was based on the following assumptions:

- Total predicted short-term air pollutant concentrations were assumed to be the sum of the assumed background concentration, plus the predicted maximum cumulative modeled concentrations, which may occur under different meteorological conditions.

- Background air pollution concentrations were assumed to occur throughout the 20-year life of project at all locations in the region; even though this background was derived from monitoring primarily conducted in urban or industrial areas, rather than rural areas. The uniform background PM_{10} levels for each state are assumed to be representative of the background conditions for the entire modeled area of the PRB, based on monitoring data gathered throughout northeastern Wyoming and southeastern Montana.

- The maximum predicted air quality impacts occur only in the vicinity of the anticipated emission sources. Actual impacts would likely be less at distances beyond the predicted points of maximum impact.

- All emission sources were assumed to operate at their reasonably foreseeable maximum emission rates simultaneously throughout the life of project. Given the number of sources included in this analysis, the co-probability of such a scenario actually occurring over an entire year is small.

- In developing the emissions inventory and model, there is uncertainty regarding ultimate development (i.e., number of wells, equipment to be used, specific locations, etc.) Most (90 percent) proposed CBM wells and 30 percent of conventional wells were assumed to be fully operational and remain operating (no shut ins) throughout the life of project.

- The total proposed booster (field) and pipeline (sales) compression engines were assumed to operate at their rated capacities continuously throughout the life of project (no phased increases or reductions). In actual developments, compression equipment is expected to be added or removed incrementally as required by the well field operation, compressor engines would operate below full horsepower ratings, and all compressor stations would not be operating at maximum levels simultaneously.

- The HAP analyses assumed a 9,900 horsepower, six-unit, reciprocating compressor engine station would operate at full load and at maximum emission levels continuously throughout the life of project.

- The emissions inventory and model use peak years of construction and peak years of operations, which would not occur throughout the entire development region at the same time. However, these conditions may occur in some areas.

- The emissions inventory and model assumed that an emission rate for compressor engines of 1.5 g/hp-hr of NO_x. Since BACT is decided on a case-by-case basis, actual emission rates could be decided to be less or more than this level by the Departments of Environmental Quality in Wyoming or Montana, and on Indian lands by EPA, for field and sales compressor engines. Actual NO_x emission rates may range from 0.7 to 2 g/hp-hr.

- There are no applicable local, state, tribal or federal acid deposition standards. In the absence of applicable standards, the acid deposition analysis assumed that a "limit of acceptable change is: a 10 percent change in ANC for lakes with a background ANC greater than 25 μeq/l; or a 1 μeq/l change in ANC for lakes with a background ANC less than 25 μeq/l, and would be a reasonably foreseeable significant adverse impact. Further, the atmospheric deposition impact analysis assumed no other ecosystem components would affect lake chemistry for a full year (assuming no chemical buffering due to interaction with vegetation or soil materials).

- The visibility impact analysis assumed that a 1.0 dv "just noticeable change" would be a reasonably foreseeable significant adverse impact, although there are no applicable local, state, tribal or federal regulatory visibility standards. However, some FLMs are using 0.5 dv as a screening threshold for significance.

- Mitigation measures are included in the emissions inventory and model that may not be achievable in all circumstances. However, actual mitigation decided by the developers and local and state authorities may be greater or less than those assumed in the analysis. For example, maintaining a construction road speed limit of 15 mph may be reasonable in a construction zone but difficult to enforce elsewhere. Full (100 percent) mitigation of fugitive dust from disturbed lands may not be achievable. Further, 50 percent reduction in fugitive emissions is assumed based on construction road wetting on the unimproved access road to the pad and at the pad, but this level

of effectiveness is characterized as the maximum possible. In the air quality modeling, no specific road wetting or other emissions were assumed to be used during the operations phase of the development (e.g., for maintenance vehicle traffic). However, during the review of proposed projects (Applications for Permit to Drill) the BLM would require specific mitigation measures in certain areas during the operational phase of development.

- Induced or secondary growth related to increases in vehicle miles traveled (VMT) (believed to be on the order of 10 percent overall) is not included in the emissions inventory and model. Not all fugitive dust emissions (including county and other collector roads) have been included in the emissions inventory and model.
- Fugitive dust emissions from roads are treated as area sources rather than line sources in the model, which may thereby reduce or increase the predicted ambient concentrations at maximum concentration receptor points near the source, depending on the inputs to the model (meteorology, terrain, etc.) By not placing modeled receptors close to emission sources (e.g. wells and roads), the model may not capture higher ambient concentrations near these sources. A more refined, regulatory model may yield higher concentrations at locations near fugitive dust sources.
- For comparisons to the PSD Class I and II increments, the emissions inventory and model included only CBM and RFFA sources. Other existing increment consuming sources such as Campbell County coal mines were not included in this comparison, as the air quality analysis does not represent a regulatory PSD increment consumption analysis. A regulatory PSD increment consumption analysis needs to identify and consider all PSD increment consuming sources to determine the level of PSD Class II increment consumption. Monitoring data in Wyoming has indicated an upward trend in PM concentrations in Campbell County since 1999, which coincides with CBM development but is also exacerbated by prolonged drought in the region.

Given these assumptions, the model represents an estimate of potential air quality impacts in the project area and region.

It is important to note that before actual development could occur, the applicable air quality regulatory agencies (including the state, tribe, or EPA) would review specific air pollutant emissions preconstruction permit applications that examine potential project-wide air quality impacts for some categories of sources. As part of these permits (depending on source size), the air quality regulatory agencies could require additional air quality impacts analyses or mitigation measures. Thus, before development occurs, additional site-specific air quality analyses would be performed to ensure protection of air quality. Emission sources that would violate standards would not be permitted.

Impacts from Management Common to All Alternatives

Air quality impacts would occur during construction (due to surface disturbance by earth-moving equipment, vehicle traffic fugitive dust, well testing, and drilling rig and vehicle engine exhaust) and production (including well production equipment and field and sales compression engine exhausts), as well as emissions associated with secondary growth. The amount of air pollutant emissions during construction and production would be controlled by watering; applying chemical stabilizers, surface material or reseeded vegetation to disturbed soils; and by air pollutant emission limitations imposed by applicable oil and gas lease management agencies and air quality regulatory agencies. Actual air quality impacts depend on the amount, duration, location, and characteristics of potential emissions sources, as well as meteorological conditions (wind speed and direction, precipitation, etc.).

Impacts from Management Specific to Each Alternative

Alternative A—No Action (Existing CBM Management)

Impacts to air quality would be minimal under this alternative. Based on air quality modeling of potential near-field (direct, indirect, and cumulative) air quality impacts (Argonne 2002), localized short-term increases in CO, NO_x, SO_2, and PM_{10} concentrations could occur, but most maximum concentrations are expected to be below applicable state and National Ambient Air Quality Standards (NAAQS), as well as NAAQS PSD increments, as shown in Table 4-3. These results are for near-field modeling. Far-field modeling results were also found to be below NAAQS and PSD Increments.

Alternative A project source emissions would not result in an increase in ANC change above 10 percent for any Class I areas in the modeling domain. For the sensitive Upper Frozen Lake, within the mandatory federal PSD Class I Bridger Wilderness Area, the predicted impact is an ANC change of 0.65 percent which equates to an 0.04 μeq/l change. This is below threshold level of 1.0 μeq/l.

Direct visibility impacts from Alternative A project source emissions are predicted to be limited to the Class II, Crow Indian Reservation. Up to 2 days annually were predicted to have a greater than "just noticeable change based on Alternative A project source emissions only. The Alternative A sources are predicted to have no direct impact on visibility in the other Class I and Class II areas (as shown in Table 4-6, under the "Project Sources Only" column.)

Cumulative Impacts

Given the extensive non-project emission sources located throughout the analysis region (including CBM developments in the Wyoming section of the Powder River Basin), there is a potential for cumulative air quality impacts from Alternative A project sources and non-project sources to exceed applicable thresholds under Alternative A. Two receptor points south of the Spring Creek Coal Mine had a maximum near-field cumulative impact of 104 $\mu g/m^3$ for 24-hour PM_{10}. When combined with the assumed background level of 105 $\mu g/m^3$, the total impact of 210 $\mu g/m^3$ would exceed the 24-hour PM_{10} NAAQS of 150 $\mu g/m^3$. Note that the Alternative A project sources contribute a maximum of 1.8 $\mu g/m^3$, as shown in Table 4-4. (Note: The contributions from each source represent maximums and do not necessarily occur at the same location.

TABLE 4-3
ALTERNATIVE A—PROJECT SOURCES CRITERIA POLLUTANT IMPACTS

Pollutant	Averaging Time	Project Modeled Impact ($\mu g/m^3$)	PSD Increments [a] ($\mu g/m^3$) Class II	Montana Background ($\mu g/m^3$)	Total Impact[b] ($\mu g/m^3$)	Montana AAQS ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
NO_2	Annual	1.94	25	11	12.9	100	100
	1-hour	20.6	n/a	117	138	566	n/a
SO_2	Annual	0.27	20	16	16	60	80
	24-hour	0.87	91	73	74	260	365
	3-hour	1.54	512	291	293	n/a	1,300
	1-hour	1.86	n/a	666	668	1,300	n/a
PM_{10}	Annual	0.52	17	30	31	50	50
	24-hour	1.83	30	105	107	150	150
$PM_{2.5}$	Annual	0.27	n/a	8	8	15	15
	24-hour	0.97	n/a	20	21	65	65
CO	8-hour	29.78	n/a	6,600	6,630	10,000	10,000
	1-hour	49.4	n/a	15,000	15,049	26,000	40,000

[a] PSD Increment is to be compared to the Project Modeled Impact .
[b] Total Impact is the sum of the Project Modeled Impact and Background values.
n/a – not applicable

Therefore the sum of the individual contributions will not always equal the cumulative totals.)

In addition, non-project sources have the potential to exceed the PSD Class I increment for 24-hour PM_{10} on the Northern Cheyenne Indian Reservation, as well as the PSD Class II increment, near the maximum assumed development area (see Table 4-5). For the Northern Cheyenne Indian Reservation the far-field analysis indicated a maximum increment level of 8.7 $\mu g/m^3$ with the non-project sources contributing 8.4 $\mu g/m^3$ and the Alternative A project sources contributing up to 0.5 $\mu g/m^3$.

Given a minimal background ANC level for Upper Frozen Lake within the mandatory federal PSD Class I Bridger Wilderness Area (5.8 μeq/l), the predicted cumulative impact of 1.6 μeq/l change would exceed the threshold level of 1.0 μeq/l. Approximately 2.5 percent of this change would be attributable to Alternative A project sources alone. It should be noted that the very low background ANC level is based on only four samples taken on 3 days between 1997 and 2000.

Potential visibility impacts were predicted to occur from non-project sources alone in every sensitive area analyzed (see Table 4-6). The Alternative A project sources in themselves were predicted to have a negligible direct impact on these areas (exception is the Class II Crow IR). However, the cumulative analysis predicted an average daily visibility impact increase of approximately 1 day per year for some Class I sensitive areas. Of the 15 mandatory federal PSD Class I areas analyzed, cumulative average annual impacts would occur at the Fitzpatrick

TABLE 4-4
ALTERNATIVE A POTENTIAL NAAQS/MAAQS EXCEEDANCES

Location	Pollutant	Contributions ($\mu g/m^3$)				Cumulative Total	NAAQS/ MAAQS
		Project Sources Only	Project + RFFA Sources	Non-Project Sources	Back-ground		
Near-Field	PM_{10} 24-hr	1.8	n/a	104	105	210	150/150

TABLE 4-5
ALTERNATIVE A POTENTIAL PSD INCREMENTS EXCEEDANCES

Location	Pollutant	Contributions ($\mu g/m^3$)				PSD Class I Increment	PSD Class II Increment
		Project Sources Only	Project + RFFA Sources	Non-Project Sources	Cumulative Total		
N. Cheyenne IR	PM_{10} 24-hr	0.5	n/a	8.4	8.7	8	
Near-Field	PM_{10} 24-hr	1.8	n/a	104	105		30

TABLE 4-6
ALTERNATIVE A CLASS I AREA POTENTIAL VISIBILITY IMPACTS

Location	Contributions Visibility (No. of days >1.0dv/yr				Maximum Δdv[1]
	Project Sources Only	Project + RFFA Sources	Non-Project Sources	Cumulative Total	
Badlands WA	0	n/a	17 to 25	18 to25	10.0
Bridger WA	0	n/a	8 to 10	8 to 10	10.9
Fitzpatrick WA	0	n/a	7 to 9	8 to 10	13.5
Fort Peck IR	0	n/a	1 to 2	2 to 2	6.0
Gates of the Mountains WA	0	n/a	3 to 4	3 to 4	12.7
Grand Teton NP	0	n/a	4 to 6	4 to 6	5.8
N. Absaroka WA	0	n/a	10 to 12	11 to 12	11.3
N. Cheyenne IR	0	n/a	30 to 38	33 to 42	39.9
Red Rock Lakes WA	0	n/a	0 to 1	0 to 1	2.3
Scapegoat WA	0	n/a	2 to 2	2 to 3	8.2
Teton WA	0	n/a	7 to 9	7 to 10	11.9
Theodore Roosevelt NP (N. Unit)	0	n/a	1 to 2	1 to 2	3.3
Theodore Roosevelt NP (S. Unit)	0	n/a	2 to 4	2 to 4	3.9
U.L. Bend WA	0	n/a	5 to 5	5 to 6	23.7
Washakie WA	0	n/a	11 to 14	12 to 15	20.
Wind Cave NP	0	n/a	21 to 27	22 to 28	7.7
Yellowstone NP	0	n/a	9 to 11	9 to 11	9.0

[1]Δdv – change in deciview

Wilderness Area (up to 10 days per year); the Scapegoat Wilderness Area (up to 3 days per year); the Teton Wilderness Area (up to 10 days per year); the Washakie Wilderness Area (up to 15 days per year); and Wind Cave National Park (up to 28 days per year).

Up to 42 days annually were predicted to have a greater than "just noticeable change" within the redesignated PSD Class I Northern Cheyenne Indian Reservation based on cumulative impact. The Alternative A project sources are predicted to have no direct impact on visibility whereas the non-project sources are predicted to have an impact of up to 38 days annually.

The maximum potential cumulative visibility impacts (see Table 4-7) predicted at the PSD Class II Crow Indian Reservation were 69 days per year with Alternative A project sources directly contributing up to 2 days per year and non-project sources contributing up to 61 days per year. Fewer cumulative impacts were predicted at other PSD Class II sensitive receptors, including the Absaroka-Beartooth Wilderness Area (30 days per year), the Bighorn Canyon National Recreation Area (23 days per year), the Cloud Peak

Wilderness Area (30 days per year), Devils Tower National Monument (39 days per year), and Jewel Cave National Monument (32 days per year). The Alternative A project sources contributed generally 1 to 2 days per year to these cumulative totals. Note that visibility impacts are due to $PM_{2.5}$, NO_2 and SO_2 emissions from project and non-project sources.

Crow Reservation

Given the proximity of proposed Alternative A emission sources near or on the Crow Indian Reservation, it is understandable that several of the maximum air pollutant impacts would occur on tribal lands. All direct, indirect, and cumulative impacts were predicted to comply with applicable air quality standards and increments. Additionally, the following potential visibility impacts were predicted to occur on the Crow Indian Reservation: up to 2 days per year from Alternative A project sources directly; up to 61 days per year from non-project sources; and up to 69 days per year from all sources cumulatively.

TABLE 4-7
ALTERNATIVE A CLASS

Location	Contributions Visibility (No. of days >1.0dv/yr)				Maximum Δdv
	Project Sources Only	Project + RFFA Sources	Non-Project Sources	Cumulative Total	
Absaroka Beartooth WA	0	n/a	28 to 29	28 to 30	15.2
Agate Fossils Bed NM	0	n/a	10 to 15	10 to 15	10.4
Bighorn Canyon NRA	0	n/a	19 to 21	19 to 23	28.2
Black Elk WA	0	n/a	20 to 26	20 to 26	8.4
Cloud Peak WA	0	n/a	21 to 28	23 to 30	13.9
Crow IR	2	n/a	56 to 61	65 to 69	53.0
Devils Tower NM	0	n/a	24 to 38	26 to 39	9.7
Fort Belknap IR	0	n/a	60 to 61	61 to 61	23.6
Fort Laramie NHS	0	n/a	13 to 17	13 to 17	14.4
Jewel Cave NM	0	n/a	24 to 31	24 to 32	11.0
Mount Rushmore NMem	0	n/a	17 to22	17 to 22	7.5
Popo Agie WA	0	n/a	8 to 10	8 to 10	11.9
Soldier Creek WA	0	n/a	13 to 18	13 to 18	9.3

Northern Cheyenne Reservation

Given the proximity of proposed Alternative A emission sources near or on the Northern Cheyenne Indian Reservation, it is understandable that some of the maximum air pollutant impacts would occur on tribal lands. With the exception of a potential non-project and cumulative sources exceedance of the 24-hour PM_{10} Class I Increments, all direct, indirect, and cumulative impacts were predicted to comply with applicable air quality standards and increments. Additionally, the following potential visibility impacts were predicted to occur on the Northern Cheyenne Indian Reservation: no increased haze days per year from Alternative A project sources directly; up to 38 days per year from non-project sources and up to 42 days per year from all sources cumulatively.

Mitigation

Roads and well locations constructed on soils susceptible to wind erosion could be appropriately surfaced to reduce the amount of fugitive dust generated by traffic or other activities. Dust inhibitors (i.e., surfacing materials, non-saline dust suppressants, water, etc.) could be used as necessary on unpaved collector, local, and resource roads, which present a fugitive dust problem. To further reduce fugitive dust, operators could establish and enforce speed limits (i.e., 15 mph) on all project-required roads in and adjacent to the project area.

Potential emission reduction measures (BLM 1999d) are available to further limit NO_x and other pollutant emissions. The appropriate level of control would be determined and required by the applicable air quality regulatory agencies during the preconstruction permit process. Visibility impacts would be mitigated by reducing emissions of $PM_{2.5}$, NO_2 and SO_2.

- **Reduce Compression Requirements.** Reducing the need for life of project compression by limiting the need for field compressors.
- **Electric Compression.** Using electric-powered compressor motors in place of the typical natural gas-fired compressor engines could eliminate direct NO_x emissions from compressor station locations.
- **BACT.** Best Available Control Technology is expected to be required by the MDEQ for compressor engines. Compressor engines would have an average potential NO_x emission rate of less than the 1.5 grams per horsepower per hour (g/hp-hr) used in the modeling assessment.

Additional discussion of particulate and NO_x emission mitigation measures is provided in the Air Quality Appendix. Some of these measures have been incorporated as management features of the alternatives (see Table 2-1 and Table 2-2 in Chapter 2).

Conclusion

Future development activities must comply with applicable local, state, tribal, and federal air quality laws, statutes, regulations, standards, increments, and implementation plans. Increases in air pollutant emissions would occur under Alternative A. Given the assumptions applied in this analysis, it is unlikely direct air quality impacts from Alternative A project sources would violate any local, state, tribal, or federal air quality standards. When combined with other non-project emission sources, the 24-hour PM_{10} PSD Class II increment and NAAQS was predicted to be exceeded near the Spring Creek Coal Mine. Additionally, the cumulative impact of Alternative A project and non-project sources was predicted to exceed the 24-hour PM_{10} PSD Class I increment at the Northern Cheyenne Indian Reservation. Finally, cumulative air quality impacts were predicted to exceed: 1) atmospheric deposition thresholds in the very sensitive Upper Frozen Lake in the PSD Class I Bridger Wilderness Area; and 2) visibility impact thresholds in all sensitive federal PSD Class I and Class II areas.

Alternative B—CBM Development with Emphasis on Soil, Water, Air, Vegetation, Wildlife, and Cultural Resources

There is the potential for direct air quality impacts to occur under this alternative. Based on air quality modeling of potential near-field (direct, indirect, and cumulative) air quality impacts (Argonne 2002), localized short-term increases in CO, NO_x, SO_2, and PM_{10} concentrations could occur, and some maximum concentrations are predicted to be above applicable state and National Ambient Air Quality Standards (NAAQS) and PSD increments.

The modeled impacts from project sources are shown in Table 4-8. These results, which are all below the MAAQS, NAAQS and PSD increments, are for near-field modeling. Far-field modeling results for project sources are also below the MAAQS, NAAQS and PSD Increments. (Refer to "Project Sources Only" columns in the following tables.)

Alternative B project sources by themselves would not result in an increase in ANC change above 10 percent for any Class I areas in the modeling domain. For the sensitive Upper Frozen Lake, within the mandatory federal PSD Class I Bridger Wilderness Area, the predicted impact is an ANC change of 3.3 percent, which equates to an 0.19 μeq/l change. This is below threshold level of 1.0 μeq/l.

Even without other development in the region, Alternative B project sources alone may directly degrade visibility within seven mandatory federal PSD Class I Areas. Impacts greater than a "just noticeable change" of 1.0 dv was predicted to average 3 days per year within the Washakie Wilderness Area (maximum 3.7 Δdv), 2 days per year within the Bridger, Fitzpatrick and North Absaroka Wilderness Areas (maximum 2.4, 2.3, and 3.6 Δdv, respectively, and 1 day per year within the Teton Wilderness Area, U.L. Bend Wilderness Area and Yellowstone National Park (maximum 2.1, 4.3 and 3.0 Δdv, respectively). Given

their proximity to anticipated Alternative B project sources, average annual visibility changes were also predicted to occur on up to 33 days within the redesignated PSD Class I Northern Cheyenne Indian Reservation (maximum 13.4 Δdv).

For PSD Class II areas, Alternative B project sources were predicted to impact visibility of greater than 1.0 dv on 9 days within the Bighorn Canyon National Recreation Area (maximum 5.4 Δdv), and on up to 61 days within the PSD Class II Crow Indian Reservation (maximum 21.5 Δdv). Less extensive potential direct visibility impacts were also predicted for the PSD Class II Absaroka-Beartooth Wilderness Area (up to 2 days per year, max. 5.0 Δdv), Cloud Peak Wilderness Area (up to 6 days per year, max. 3.8 Δdv), Popo Agie Wilderness Area (up to 2 days per year, max. 2.6 Δdv), Devils Tower National Monument (up to 1 day per year, max. 2.8 Δdv) and Fort Belknap Indian Reservation (up to 1 day per year, max. 4.1 Δdv).

TABLE 4-8
ALTERNATIVE B—PROJECT SOURCES CRITERIA POLLUTANT IMPACTS

Pollutant	Averaging Time	Project Modeled Impact ($\mu g/m^3$)	PSD[1] Increments Class II ($\mu g/m^3$)	Montana Background ($\mu g/m^3$)	Total[2] Impact ($\mu g/m^3$)	Montana AAQS ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
NO_2	Annual	9.1	25	11	20.1	100	100
	1-hour	99.7	n/a	117	217	566	n/a
SO_2	Annual	0.66	20	16	17	60	80
	24-hour	2.1	91	73	75	260	365
	3-hour	3.5	512	291	295	n/a	1,300
	1-hour	4.6	n/a	666	671	1,300	n/a
PM_{10}	Annual	3.6	17	30	34	50	50
	24-hour	12.1	30	105	117	150	150
$PM_{2.5}$	Annual	1.4	n/a	8	9	15	15
	24-hour	6.2	n/a	20	26	65	65
CO	8-hour	74.1	n/a	6,600	6,674	10,000	10,000
	1-hour	109	n/a	15,000	15,109	26,000	40,000

[1] PSD Increment is to be compared to the Project Modeled Impact.
[2] Total Impact is the sum of the Project Modeled Impact and Background values.
n/a – not applicable

Temporary Impacts

Based on modeling, the potential maximum 24-hour average PM_{10} concentration due to fugitive dust emissions from the largest construction site of the Montana Project (6-acre sales compressor station with a two-track road 480 m long and 12 m wide) was estimated to be about 57 $\mu g/m^3$, occurring about 400 m away from the center of construction site and about 200 m from the road. Although the temporary, short-term impacts of fugitive dust emissions from a construction site are not usually subjected to the requirements of ambient air quality standards, the total PM_{10} concentration, including the contributions from the largest construction site of the Montana Project, was estimated and compared with applicable MTAAQS and NAAQS. Adding the estimated potential maximum 24-hour average PM_{10} concentration increase of 57 $\mu g/m^3$ to the background concentration of 105 $\mu g/m^3$ would amount to a total

concentration of about 162 μg/m^3, which is about 108 percent of MTAAQS. All other construction sites of the Montana Project would be smaller in size than the 6-acre sales compressor station construction site, and therefore, potential PM_{10} concentration impacts at these smaller sites would be less.

In addition, it is anticipated that temporary electrical generators would be used during construction of the compressor stations. The exact number of temporary natural gas and diesel generators for compressor stations cannot be predicted, but typical emission factors were used to estimate the near-field impacts from one temporary diesel generator. The potential ground-level concentrations resulting from operation of a temporary generator are as follows: CO 1-hour up to 403 μg/m^2, CO 8-hour up to 243 μg/m^2; NO_2 24-hour up to 7.5 μg/m^2; NO_2 annual up to 5.3 μg/m^2; $PM_{2.5}$ 3-hour up to 0.4 μg/m^2; $PM_{2.5}$ annual up to 0.4 μg/m^2; SO_2 3-hour up to 0.4 μg/m^2; SO_2 24-hour up to 0.3 μg/m^2; and SO_2 annual up to 0.013 μg/m^2. All concentrations are well below the ambient air quality standards.

The HAP impact analysis was based on a maximum assumed six-unit reciprocating compressor engine station as described in the Air Quality Modeling Appendix. Since neither the MDEQ nor EPA have established HAP standards, predicted 8-hour HAP concentrations were compared to a range of 8-hour state maximum Acceptable Ambient Concentration Levels (EPA 1997a). Formaldehyde was the only HAP predicted to exceed even the lowest threshold level. The maximum predicted cumulative 8-hour formaldehyde impact was 11.9 μg/m^3, which is within the threshold range of 4.5 μg/m^3 (Pinnellas County Air Pollution Control Board, Florida) to 71 μg/m^3 (State of Nevada, Division of Environmental Protection, Air Quality Control). The maximum formaldehyde concentration was predicted to occur at 85 meters (less then 300 feet) adjacent to a compressor station; as the distance from the emission source increases, the predicted concentrations decrease rapidly.

Analysis was conducted to determine the possible incremental cancer-risk over a 70 year lifetime for a most likely exposure (MLE) to residents, and to a maximally exposed individual (MEI), such as compressor station workers. These cancer risks were calculated based on the maximum predicted annual concentrations, EPA's unit risk factors for carcinogenic compounds (EPA 1997b), and an adjustment for time spent at home or on the job. This analysis assumed that residential exposure would be 20 years (well over the national nine year average duration a family lives at a residence) and worker exposure would be 20 years (the full life of project). In addition, it was assumed that family members would be exposed to the maximum formaldehyde concentrations 64 percent of the day, and to one forth of this concentration for the remaining 36 percent of the day.

The resulting incremental cancer risks were calculated to be 1.6 x 10^{-6} (MLE) and 2.2 x 10^{-6} (MEI). Both of these values fall near the lower end of the 1 to 100 x 10^{-6} threshold. The MLE and MEI cancer risks would fall below this threshold at 310 and 460 meters away from the emission source, respectively. This distance would be even less for smaller compressors.

Cumulative Impacts

Given the non-project emission sources located throughout the analysis region, there is a potential for cumulative air quality impacts to exceed applicable thresholds under Alternative B. Two receptor points south of the Spring Creek Coal Mine had a maximum near-field cumulative impact of 107 μg/m^3 for 24-hr PM_{10}. When combined with the assumed background level of 105 μg/m^3, the total impact of 211 μg/m^3 would exceed the 24-hour PM_{10} NAAQS of 150 μg/m^3. The Alternative B project sources contribute a maximum 12.1 μg/m^3 alone. The project sources combined with the RFFA (Indian Reservation and Forest Service) developments contribute a total of 13.1 μg/m^3 and the non-project sources contributed 104μg/m^3. (Note: The contributions from each source represent maximums and do not necessarily occur at the same location. Therefore the sum of the individual contributions will not always equal the cumulative totals.)

Furthermore, a maximum near-field cumulative impact for 24-hour $PM_{2.5}$ was determined to be 46 μg/m^3. When combined with the assumed background level of 20 μg/m^3, the total impact of 66 μg/m^3 would exceed the 24-hour $PM_{2.5}$ NAAQS of 65 μg/m^3. Note that the Alternative B project sources contribute a maximum 6.2 μg/m^3 alone. The project sources combined with the RFFA (Indian Reservation and Forest Service) developments contribute a total of 6.9 μg/m^3 (see Table 4-9).

In addition, Alternative B non-project sources have the potential to exceed the PSD Class I increment for 24-hour PM_{10} on the Northern Cheyenne Indian Reservation and the Washakie Wilderness area. For the Northern Cheyenne Indian Reservation the far-field analysis indicated a maximum increment level of 12.8 μg/m^3 with the non-project sources contributing 8.4 μg/m^3 and project sources contributing up to 4.2 μg/m^3 alone. The project sources combined with the RFFA

(Indian Reservation and Forest Service) developments contribute a total of 5.9 μg/m^3.

For the Washakie Wilderness Area the far-field analysis indicated a maximum increment level of 9.2 μg/m^3 with the non-project sources contributing 7.2 μg/m^3 and project sources contributing up to 1.4 μg/m^3 alone. The project sources combined with the RFFA (Indian Reservation and Forest Service) developments contribute a total of 2.0 μg/m^3.

Alternative B non-project sources also have the potential to exceed the PSD Class I increment for annual NO_2 on the Northern Cheyenne Indian Reservation (see Table 4-10). The far-field analysis indicated a maximum increment level of 4.2 μg/m^3 with the non-project sources contributing 0.5 μg/m^3 and project sources contributing up to 1.9 μg/m^3 alone. The project sources combined with the RFFA (Indian Reservation and Forest Service) developments contribute a total of 3.7 μg/m^3.

For Class II areas near the Spring Creek Coal Mine, the cumulative impact of 107 μg/m^3 exceeds the Class II increment of 30 μg/m^3 for 24-hour PM_{10}. The non-project source contribution was predicted to be up to 104μg/m^3 and the project source contribution was predicted to be up to 12.1 μg/m^3 alone. The project

TABLE 4-9
ALTERNATIVE B POTENTIAL NAAQS/MAAQS EXCEEDANCES

		Contributions (μg/m^3)					
Location	**Pollutant**	**Project Sources Only**	**Project + RFFA Sources**	**Non-Project Sources**	**Back-ground**	**Cumulative Total**	**NAAQS/ MAAQS**
Near-Field	$PM_{2.5}$ 24-hr	6.2	6.9	44.1	20	66	65/---
Near-Field	PM_{10} 24-hr	12.1	13.1	104	105	212	150/150

TABLE 4-10
ALTERNATIVE B POTENTIAL PSD INCREMENTS EXCCEDANCES

		Contributions (μg/m^3)					
Location	**Pollutant**	**Project Sources Only**	**Project + RFFA Sources**	**Non-Project Sources**	**Cumulative Total**	**PSD Class I Increment**	**PSD Class II Increment**
N. Cheyenne IR	PM_{10} 24-hr	4.2	5.9	8.4	12.8	8	
N. Cheyenne IR	NO_2 Annual	1.9	3.7	0.5	4.2	2.5	
Washakie WSA	PM_{10} 24-hr	1.4	2.0	7.2	9.2	8	
Near-Field	PM_{10} 24-hr	12.1	13.1	103.8	107		30

sources combined with the RFFA (Indian Reservation and Forest Service) developments contribute a total of 13.1 $\mu g/m^3$.

Given a minimal background ANC level for Upper Frozen Lake within the mandatory federal PSD Class I Bridger Wilderness Area (5.8 μeq/l), the predicted cumulative impact of 1.8 μeq/l change would exceed the threshold level of 1.0 μeq/l. Approximately 11 percent of this change would be attributable to Alternative B project sources alone. Additionally, the potential cumulative impact of 10.4 μeq/l change would exceed the threshold level of 10 μeq/l for Florence Lake in the Class II Cloud Peak Wilderness Area.

Note that potential visibility impacts were predicted to occur from Alternative B non-project sources alone in every sensitive area analyzed. When Alternative B project sources are included in the cumulative analysis, average daily visibility impacts increase by 1 to 3 days per year at most areas, except the Northern Cheyenne Indian Reservation and Class II Crow Reservation. Both are located near the potential Alternative B sources.

Cumulative impacts from non-project, Alternative B and RFFA sources are likely to degrade visibility within fourteen of the fifteen mandatory federal PSD Class I Areas. When Alternative B project sources are combined with the RFFA (Indian Reservation and Forest Service) developments cumulative impacts resulted in an increase of 1 to 5 days per year, as shown in the table below. The cumulative impacts ranged from a total of 2 to 32 days per year for these Class I areas with a maximum Δdv of 29.1 for the U.L. Bend WA.

Modeled project sources could impact seven of the PSD Class I Areas. A "just noticeable change" of 1.0 dv was predicted to average 3 day per year within the Washakie Wilderness Area, 2 days per year within the Bridger, Fitzpatrick and North Absaroka Wilderness Areas, and 1 day per year within the Teton Wilderness Area, U.L. Bend Wilderness Area and Yellowstone National Park (see Table 4-11).

Given their proximity to anticipated Alternative B emission sources, cumulative average annual visibility changes were also predicted to occur on up to 92 days per year within the redesignated PSD Class I Northern Cheyenne Indian Reservation. The maximum Δdv was modeled to be 54.8. Project sources alone contributed up to 33 days per year. The project sources combined with the RFFA (Indian Reservation and Forest Service) developments contribute a total of 60 days per year. Although no direct visibility impacts to the Fort Peck IR may be attributable to Alternative B project sources, the cumulative impact was predicted to increase 3 days per year with a maximum Δdv of 7.4.

For PSD Class II areas, cumulative impacts from project sources combined with the RFFA (Indian Reservation and Forest Service) sources and non-project sources were predicted to be 11 days to 116 days per year, as shown in Table 4-12 below with a maximum Δdv of 66.9 (on Crow IR). The Alternative B project sources combined with RFFA sources contributed generally 1 to 55 days per year to these cumulative totals. Alternative B project source impacts were predicted to occur on 9 days within the Bighorn Canyon National Recreation Area, and on up to 61 days within the PSD Class II Crow Indian Reservation. Less extensive potential direct visibility impacts were also predicted for the PSD Class II Absaroka-Beartooth Wilderness Area (up to 9 days per year), Cloud Peak Wilderness Area (up to 6 days per year), Popo Agie Wilderness Area (up to 2 days per year), Devils Tower National Monument (up to 1 day per year) and Fort Belknap Indian Reservation (up to 1 day per year). Note that visibility impacts are due to $PM_{2.5}$, NO_2 and SO_2 emissions from project and non-project sources.

Crow Reservation

Given the proximity of proposed Alternative B emission sources near or on the Crow Indian Reservation, it is understandable that air pollutant impacts would occur on tribal lands. All direct, indirect, and cumulative impacts were predicted to comply with applicable air quality standards and increments. Additionally, the following potential visibility impacts were predicted to occur on the Crow Indian Reservation: up to 61 days per year from Alternative B project sources directly; up to 75 days per year from project and RFFA sources; up to 61 days per year from non-project sources; and up to 116 days per year from all sources cumulatively. The maximum Δdv was 66.9.

Northern Cheyenne Reservation

Given the proximity of proposed Alternative B emission sources near or on the Northern Cheyenne Indian Reservation, it is understandable that some of the maximum air pollutant impacts could occur on tribal lands. With the exception of a potential non-project and cumulative source exceedance of the 24-hour PM_{10} and annual NO_2 Class I Increments, all direct, indirect, and cumulative impacts were predicted to comply with applicable air quality standards and increments. Additionally, the following potential visibility impacts were predicted to occur on the

Northern Cheyenne Indian Reservation: up to 33 days per year from Alternative B project sources directly; up to 60 days per year from project and RFFA sources; up to 38 days per year from non-project sources and up to 92 days per year from all sources cumulatively. The maximum Δdv was 54.5.

Mitigation

Potential mitigation measures to further reduce potential air quality impacts from Alternative B sources would be the same as those presented for Alternative A sources above.

Conclusion

Future development activities must comply with applicable local, state, tribal, and federal air quality laws, statutes, regulations, standards, increments, and implementation plans. Increases in air pollutant emissions that could occur under Alternative B, resulting in direct air quality impacts would not be permitted. It is unlikely direct air quality impacts from Alternative B project sources alone would violate local, state, tribal or federal air quality standards.

TABLE 4-11
ALTERNATIVE B CLASS I AREA POTENTIAL VISIBILITY IMPACTS

	Contributions Visibility (No. of days >1.0dv/yr)				
Location	**Project Sources Only**	**Project + RFFA Sources**	**Non-Project Sources**	**Cumulative Total**	**Maximum Δdv**
Badlands WA	0	0	17 to 25	21 to28	10.9
Bridger WA	2	3	8 to 10	10 to 12	13.3
Fitzpatrick WA	2	3	7 to 9	10 to 12	16.6
Fort Peck IR	0	1	1 to 2	4 to 5	7.4
Gates of the Mountains WA	0	0	3 to 4	4 to 4	15.0
Grand Teton NP	0	0	4 to 6	6 to 8	7.0
N. Absaroka WA	2	4	10 to 12	13 to 15	14.9
N. Cheyenne IR	33	60	30 to 38	87 to 92	54.8
Red Rock Lakes WA	0	0	0 to 1	2 to 3	2.9
Scapegoat WA	0	0	2 to 2	3 to 3	9.9
Teton WA	1	3	7 to 9	10 to 11	14.6
Theodore Roosevelt NP (N. Unit)	0	0	1 to 2	2 to 3	3.7
Theodore Roosevelt NP (S. Unit)	0	1	2 to 4	4 to 7	4.6
U.L. Bend WA	1	1	5 to 5	6 to 8	29.1
Washakie WA	3	5	11 to 14	16 to 18	24.8
Wind Cave NP	0	0	21 to 27	25 to 32	9.1
Yellowstone NP	1	3	9 to 11	12 to 13	12.8

TABLE 4-12
ALTERNATIVE B CLASS II AREA POTENTIAL VISIBILITY IMPACTS

Location	Contributions Visibility (No. of days >1.0dv/yr)				
	Project Sources Only	Project + RFFA Sources	Non-Project Sources	Cumulative Total	Maximum Δdv
Absaroka Beartooth WA	2	4	28 to 29	32 to 33	21.5
Agate Fossils Bed NM	0	0	10 to 15	14 to 19	12.8
Bighorn Canyon NRA	9	17	19 to 21	32 to 34	34.0
Black Elk WA	0	1	20 to 26	24 to 31	9.4
Cloud Peak WA	6	10	21 to 28	35 to 39	16.3
Crow IR	61	75	56 to 61	113 to 116	66.9
Devils Tower NM	1	3	24 to 38	34 to 47	11.4
Fort Belknap IR	1	1	60 to 61	61 to 62	28.4
Fort Laramie NHS	0	1	13 to 17	16 to 20	16.9
Jewel Cave NM	0	0	24 to 31	28 to 36	12.1
Mount Rushmore NMem	0	0	17 to22	20 to 26	8.4
Popo Agie WA	2	3	8 to 10	11 to 13	14.6
Soldier Creek WA	0	0	13 to 18	16 to 21	11.4

When Alternative B project source impacts are combined with the RFFA (Indian Reservation and Forest Service) sources and non-project sources, the 24-hour PM_{10} NAAQS and the 24-hour $PM_{2.5}$ NAAQS were predicted to be exceeded near the Spring Creek Coal Mine. In addition, cumulative impact of Alternative B project, RFFA and non-project sources have the potential to exceed the PSD Class I increment for 24-hour PM_{10} and PSD Class I Increment for annual NO_2 on the Northern Cheyenne Indian Reservation, as well as the PSD Class I increment for 24-hour PM_{10} on the Washakie Wilderness area.

For Class II areas near the Spring Creek Coal Mine, the cumulative impact of 107 $\mu g/m^3$ exceeds the Class II increment of 30 $\mu g/m^3$ for 24-hour PM_{10}.

Finally, cumulative air quality impacts were predicted to exceed: 1) atmospheric deposition thresholds in the very sensitive Upper Frozen Lake in the PSD Class I Bridger Wilderness Area and in Florence Lake in the Class II Cloud Peak Wilderness Area; and 2) visibility impact thresholds in all PSD Class I and Class II area (including 15 mandatory federal PSD Class I areas) included in this analysis.

Alternative C—Emphasize CBM Development

Potential direct and cumulative air quality impacts are comparable to Alternative B.

Alternative D—Encourage CBM Exploration and Development While Maintaining Existing Land Uses

Potential direct air quality impacts could occur under this alternative. Based on air quality modeling of potential near-field (direct, indirect, and cumulative) air quality impacts (Argonne 2002), localized short-term increases in CO, NO_x, SO_2, and PM_{10} concentrations could occur, but most maximum

concentrations are expected to be below applicable state and NAAQS, as well as NAAQS PSD increments and some maximum concentrations are predicted to be above applicable state and NAAQS and PSD increments.

The modeled impacts from project sources only are shown in Table 4-13 below. These results, which are all below the MAAQS, NAAQS and PSD increments, are for near-field modeling. Far-field modeling results for project sources were also found to be below the MAAQS, NAAQS and PSD Increments. (Refer to "Project Sources Only" columns in the following tables.)

Alternative D project sources by themselves would not result in an increase in ANC change above 10 percent for any Class I areas in the modeling domain. For the sensitive Upper Frozen Lake, within the mandatory federal PSD Class I Bridger Wilderness Area, the predicted impact is an ANC change of 1.8 percent, which equates to an 0.1 μeq/l change. This is below threshold level of 1.0 μeq/l set as the level of significant impact.

Alternative D project sources by themselves are likely to directly degrade visibility within one mandatory federal PSD Class I Area. A greater than "just noticeable change" of 1.0 dv was predicted to average 1 day per year within the Washakie Wilderness Area (maximum 2 Δdv) and up to 17 days within the redesignated PSD Class I Northern Cheyenne Indian Reservation (maximum 8 Δdv).

For PSD Class II areas, Alternative D project sources were predicted to impact visibility greater than 1.0 dv on 3 days within the Bighorn Canyon National Recreation Area (maximum 3 Δdv), 1 day within the Cloud Peak Wilderness Area (maximum 2 Δdv) and up to 42 days within the PSD Class II Crow Indian Reservation (maximum 11 Δdv).

Temporary Impacts

Temporary impacts for Alternative D are expected to be comparable to those described under Alternative B.

Cumulative Impacts

Given the non-project emission sources located throughout the analysis region, there is a potential for cumulative air quality impacts to exceed applicable thresholds under Alternative D (see Table 4-14). Two receptor points south of the Spring Creek Coal Mine had a maximum near-field cumulative impact of 106 $\mu g/m^3$. When combined with the assumed background level of 105 $\mu g/m^3$, the total impact of 211 $\mu g/m^3$ would exceed the 24-hour PM_{10} NAAQS of 150 $\mu g/m^3$. The Alternative D project source emissions would contribute a maximum of 10.8 $\mu g/m^3$ alone. The project and RFFA sources combined would contribute a maximum of 11.5 $\mu g/m^3$. (Note: The contributions from each source represent maximums and do not necessarily occur at the same location. Therefore the sum of the individual contributions will not always equal the cumulative totals.)

Furthermore, a maximum near-field cumulative impact for 24-hour $PM_{2.5}$ was determined to be 45.3 $\mu g/m^3$. When combined with the assumed background level of 20 $\mu g/m^3$, the total impact of 65.3 $\mu g/m^3$ would exceed the 24-hour $PM_{2.5}$ NAAQS of 65 $\mu g/m^3$. Note that the Alternative D project sources contribute a maximum 4.3 $\mu g/m^3$ alone. The project and RFFA sources combined contribute 4.7 $\mu g/m^3$.

In addition, Alternative D non-project sources have the potential to exceed the PSD Class I increment for 24-hour PM_{10} on the Northern Cheyenne Indian Reservation (see Table 4-15). The far-field analysis indicated a maximum increment level of 9.8 $\mu g/m^3$ with the non-project sources contributing 8.4 $\mu g/m^3$ and the project sources contributing up to 3.3 $\mu g/m^3$alone. The project and RFFA sources combined contribute 4.4 $\mu g/m^3$.The far-field analysis also indicated a maximum cumulative increment level of 8.1 $\mu g/m^3$ for the Washakie WA. Non-project sources were determined to contribute 7.2 $\mu g/m^3$ and the project sources contributing up to 0.61 $\mu g/m^3$alone. The project and RFFA sources combined contribute 0.85 $\mu g/m^3$.

For Class II areas near the Spring Creek Coal Mine, the cumulative impact of 106 $\mu g/m^3$ exceeds the Class II increment of 30 $\mu g/m^3$ for 24-hour PM_{10}. The non-project sources contribution was predicted to be up to 104 $\mu g/m^3$ and the project sources contributions were predicted to be up to 10.8 $\mu g/m^3$ alone. The project and RFFA sources combined contribute 11.5 $\mu g/m^3$.

Given a minimal background ANC level for Upper Frozen Lake within the mandatory federal PSD Class I Bridger Wilderness Area (5.8 μeq/l), the predicted cumulative impact of 1.7 μeq/l change would exceed the threshold level of 1.0 μeq/l. Approximately 6 percent of this change would be attributable to Alternative D project sources alone.

TABLE 4-13
ALTERNATIVE D—PROJECT SOURCES CRITERIA POLLUTANT IMPACTS

Pollutant	Averaging Time	Project Modeled Impact ($\mu g/m^3$)	PSD Increments[1] ($\mu g/m^3$) Class II	Montana Background ($\mu g/m^3$)	Total[2] Impact ($\mu g/m^3$)	Montana AAQS ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
NO_2	Annual	6.4	25	17.4	20.1	100	100
	1-hour	49.5	n/a	167	217	566	n/a
SO_2	Annual	0.65	20	16.7	17	60	80
	24-hour	2.1	91	75.1	75	260	365
	3-hour	3.5	512	295	295	n/a	1,300
	1-hour	4.5	n/a	671	671	1,300	n/a
PM_{10}	Annual	3.3	17	33.3	34	50	50
	24-hour	10.8	30	116	117	150	150
$PM_{2.5}$	Annual	1.2	n/a	9.2	9	15	15
	24-hour	4.3	n/a	24.3	26	65	65
CO	8-hour	29.1	n/a	6,629	6,674	10,000	10,000
	1-hour	47.6	n/a	15,048	15,109	26,000	40,000

[1] PSD Increment is to be compared to the Project Modeled Impact .
[2] Total Impact is the sum of the Project Modeled Impact and Background values.
n/a – not applicable

TABLE 4-14
ALTERNATIVE D POTENTIAL NAAQS/MAAQS EXCEEDANCES

		Contributions ($\mu g/m^3$)					
Location	Pollutant	Project Sources Only	Project + RFFA Sources	Non-Project Sources	Back-ground	Cumulative Total	NAAQS/ MAAQS
Near-Field	$PM_{2.5}$ 24-hr	4.3	4.7	44.1	20	65	65/---
Near-Field	PM_{10} 24-hr	10.8	11.5	103.8	105	211	150/150

TABLE 4-15
ALTERNATIVE D POTENTIAL PSD INCREMENTS EXCEEDANCES

		Contributions ($\mu g/m^3$)					
Location	**Pollutant**	**Project Sources Only**	**Project + RFFA Sources**	**Non-Project Sources**	**Cumulative Total**	**PSD Class I Increment**	**PSD Class II Increment**
N. Cheyenne IR	PM_{10} 24-hr	3.3	4.4	8.4	11.1	8	
Washakie WSA	PM_{10} 24-hr	0.61	0.85	7.2	8.1	8	
Near-Field	PM_{10} 24-hr	10.8	11.5	103.8	106.5		30

Note that potential visibility impacts were predicted to occur from Alternative D non-project sources alone in every sensitive area analyzed. When Alternative D project and RFFA sources are included in the cumulative analysis, the average daily visibility impacts increase by 1 to 2 days per year for thirteen of the fifteen areas as noted (see Table 4-16). The maximum Δdv was predicted to be 26.0 at the U.L. Bend WA.

Alternative D project sources alone are likely to directly degrade visibility within only one of the fifteen mandatory federal PSD Class I Areas. A change of 1.6 dv was predicted to average 1 day per year within the Washakie Wilderness Area.

For PSD Class II areas, Alternative D project source impacts were predicted to occur on up to 1 day within the Cloud Peak Wilderness Area (maximum 1.9 Δdv) and up to 3 days within the Bighorn Canyon National Recreation Area (maximum 2.6 Δdv). Cumulative impacts from project with RFFA sources and non-project sources were predicted to be up to 35 days and 28 days per year, respectively.

The Alternative D project sources with RFFA sources contributed generally 1 to 7 days per year to the cumulative totals for the Class II areas listed in Table 4-17. The maximum Δdv was predicted to be 30.6 at the Bighorn Canyon NRA and 59.3 at the Crow Indian Reservation. Note that visibility impacts are due to $PM_{2.5}$, NO_2 and SO_2 emissions from project and non-project sources.

Crow Reservation

Given the proximity of proposed Alternative D emission sources near or on the Crow Indian Reservation, it is understandable that air pollutant impacts would occur on tribal lands. All direct, indirect, and cumulative impacts were predicted to comply with applicable air quality standards and increments. Additionally, the following potential visibility impacts were predicted to occur on the Crow Indian Reservation: up to 42 days per year from Alternative D project sources directly; up to 56 days per year from project and RFFA sources combined; up to 61 days per year from non-project sources; and up to 105 days per year from all sources cumulatively. The maximum Δdv was predicted to be 59.3.

Northern Cheyenne Reservation

Given the proximity of proposed Alternative D emission sources near or on the Northern Cheyenne Indian Reservation, it is understandable that air pollutant impacts would occur on tribal lands. With the exception of a potential non-project and cumulative source exceedance of the 24-hour PM_{10} Class I Increments, all direct, indirect, and cumulative impacts were predicted to comply with applicable air quality standards and increments. Additionally, the following potential visibility impacts were predicted to occur on the Northern Cheyenne Indian Reservation: up to 17 days per year from Alternative D project sources directly; up to 38 days per year from project and RFFA sources combined;

TABLE 4-16
ALTERNATIVE D CLASS I AREA POTENTIAL VISIBILITY IMPACTS

Location	Contributions Visibility (No. of days >1.0dv/yr)				Maximum Δdv
	Project Sources Only	Project + RFFA Sources	Non-Project Sources	Cumulative Total	
Badlands WA	0	0	17 to 25	20 to26	10.4
Bridger WA	0	1	8 to 10	9 to 11	11.7
Fitzpatrick WA	0	0	7 to 9	8 to 10	14.6
Fort Peck IR	0	0	1 to 2	2 to 3	6.5
Gates of the Mountains WA	0	0	3 to 4	3 to 4	13.7
Grand Teton NP	0	0	4 to 6	5 to 7	6.3
N. Absaroka WA	0	1	10 to 12	12 to 14	12.4
N. Cheyenne IR	17	38	30 to 38	70 to 76	47.9
Red Rock Lakes WA	0	0	0 to 1	1 to 2	2.6
Scapegoat WA	0	0	2 to 2	2 to 3	8.9
Teton WA	0	0	7 to 9	9 to 10	12.9
Theodore Roosevelt NP (N. Unit)	0	0	1 to 2	1 to 2	3.5
Theodore Roosevelt NP (S. Unit)	0	0	2 to 4	3 to 5	4.2
U.L. Bend WA	0	0	5 to 5	5 to 6	26
Washakie WA	1	1	11 to 14	14 to 16	21.9
Wind Cave NP	0	0	21 to 27	23 to 29	8.2
Yellowstone NP	0	0	9 to 11	11 to 12	10.5

TABLE 4-17
ALTERNATIVE D CLASS II AREA POTENTIAL VISIBILITY IMPACTS

Location	Contributions Visibility (No. of days >1.0dv/yr)				Maximum Δdv
	Project Sources Only	Project + RFFA Sources	Non-Project Sources	Cumulative Total	
Absaroka Beartooth WA	0	1	28 to 29	30 to 31	17.8
Agate Fossils Bed NM	0	0	10 to 15	12 to 17	11.4
Bighorn Canyon NRA	3	7	19 to 21	25 to 28	30.6
Black Elk WA	0	0	20 to 26	22 to 28	8.8
Cloud Peak WA	1	2	21 to 28	28 to 35	14.9
Crow IR	42	56	56 to 61	102 to 105	59.3
Devils Tower NM	0	0	24 to 38	29 to 42	10.3
Fort Belknap IR	0	0	60 to 61	61 to 61	25.5
Fort Laramie NHS	0	0	13 to 17	15 to 18	15.5
Jewel Cave NM	0	0	24 to 31	26 to 34	11.5
Mount Rushmore Nmem	0	0	17 to22	18 to 23	7.9
Popo Agie WA	0	1	8 to 10	9 to 11	12.9
Soldier Creek WA	0	0	13 to 18	14 to 20	10.1

up to 38 days per year from non-project sources; and, up to 76 days per year from all sources cumulatively. The maximum Δdv was predicted to be 47.9.

Mitigation

Potential mitigation measures to further reduce potential air quality impacts from Alternative D sources would be the same as those presented for Alternative A sources above.

Conclusion

Future development activities must comply with applicable local, state, tribal, and federal air quality laws, statutes, regulations, standards, increments, and implementation plans. Increases in air pollutant emissions would occur under Alternative D. Given the assumptions applied in this analysis, it is unlikely direct air quality impacts from Alternative D project sources alone would violate any local, state, tribal, or federal air quality standards.

When combined with Alternative D non-project sources and RFFA sources, the 24-hour PM_{10} NAAQS and 24-hour $PM_{2.5}$ NAAQS was predicted to be exceeded near the Spring Creek Coal Mine. In addition, the cumulative impact from Alternative D project sources with RFFA sources and non-project sources have the potential to exceed the PSD Class I increment for 24-hour PM_{10} on the Northern Cheyenne Indian Reservation. For Class II areas near the Spring Creek Coal Mine, the cumulative impact is predicted to exceed the Class II increment for 24-hour PM_{10}.

Finally, cumulative air quality impacts were predicted to exceed: 1) atmospheric deposition thresholds in the very sensitive Upper Frozen Lake in the PSD Class I Bridger Wilderness Area; and 2) visibility impact thresholds in all PSD Class I and Class II areas (including 15 mandatory federal PSD Class I areas) included in this analysis.

Alternative E—Preferred CBM Development Alternative

Potential direct and cumulative air quality impacts are comparable to Alternative B. Although the air quality modeling shows the potential for certain standards to be exceeded, these impacts would not occur. The air quality permitting process would be used to analyze emission sources at the project level for CBM development and develop any mitigation needed. Emission sources that would violate standards would not be permitted by the agencies and therefore, residual impacts would remain within standards.

Cultural Resources

Cultural Resources *Approximately 73,600 cultural resource sites exist above known coal resources within the CBM emphasis area*
Alternative A **No Action (Existing CBM Management)**
• An estimated 17 cultural resource sites could be identified during foreseen CBM activities. Of these only one or two would likely be eligible for the NRHP. • Cumulative Impacts: – An estimated 4,285 cultural sites could be identified resulting in 430 to 612 sites that could be eligible for the NRHP.
Alternatives B, C, D, and E
• The number of cultural resource sites identified would be practically the same for Alternatives B, C, D, and E based on the level of development, associated area of disturbance and minor differences between the alternative realty management actions. An estimated 630 cultural resource sites could be identified, of these sites, 120 to 170 could be eligible for the NRHP. • Cumulative Impacts: – An estimated 5,135 cultural sites could be identified resulting in 515 to 735 sites that could be eligible for the NRHP. – Potential for impacts to TCPs would increase with the development of CBM.

Assumptions

Cultural resources would be treated similarly and equally in terms of type, composition, and significance; their distributions and densities are detailed in Chapter 3. Cultural resources are treated in this manner only for purposes of evaluation in this report, since the particular cultural resources to be affected are not necessarily known at this time. It must be understood that not all cultural resources are equal in terms of importance, National Register eligibility, density, and location. Federally recognized tribes will need to be consulted as to their needs for cultural resources even off reservation. Most of the mitigation for Native American cultural resources will entail avoidance, particularly any site associated with burials of human remains. Cultural resource attributes will have to be taken into consideration when impacts are considered for each individual CBM development. Operators will need to develop an approach for mitigating cultural resources based on the plan for CBM development that they submit. The Cultural Resource section of that plan will need to include the following guidelines in BLM's 8100 Manual Series, the Secretary of the Interior's Standards and Guidelines For Archaeology and Historic Preservation (FR 48 (190)44716-44742, 1983), and the Advisory Council on Historic Preservation's document the "Treatment of Archaeological Properties" (ACHP 1980)

Surface disturbance assumptions are detailed in the *Analysis Assumptions and Guidelines* section of this chapter. There would be one site for every 100 acres surveyed for cultural resources. This assumption was made by averaging the number of sites vs. acres surveyed in the planning area from existing surveys. This estimate is based on surveys that covered 19 percent of the estimated CBM development area. The actual number of cultural resources in a particular CBM development field could vary dramatically depending on the exact location of the field.

Impacts From Management Common To All Alternatives

Cultural resources would be impacted by surface and subsurface disturbing activities. Activities that involve the use of heavy equipment (road construction, well drilling, pad construction, pipeline and utility placement, etc.) that result in changes to the natural landscape could cause the most disturbance and could have the greatest effect on cultural resources. Other activities, such as increased travel and vandalism resulting from access improvements, and increased erosion resulting from surface disturbances, would also impact cultural resources. These activities can also produce indirect impacts to cultural resources from fires; and to rock art sites from gas emissions, abrasive dust, and vibrations from drilling equipment. Noise, activity, traffic and smells can affect the quality and continued use of Traditional Cultural Properties (TCPs). Traditional Cultural Properties important to the Northern Cheyenne and Crow and their perceptions of mitigation are presented in The Northern Cheyenne Tribe and its Reservation: 2002 (The Northern Cheyenne Tribe 2002), Crow Indian Reservation (Crow Tribe of Indians 2002) and An Ethnographic Overview of Southeast Montana (Peterson and Deaver 2002).

Impacts would occur at an estimated 318 cultural resource sites. Of these sites, 32 to 46 are projected to be eligible for the National Register of Historic Places. The estimated number of sites includes 176 cultural resource sites from disturbance by conventional oil and gas development, and 142 sites as a result of impacts caused by cumulative projects foreseen including surface coal mining activities. Additional cultural site could be found as a result of cultural resource inventories conducted before beginning surface disturbing activities. Locating cultural resource sites

would result in the accumulation of additional artifacts and information.

Impacts from Management Specific to Each Alternative

Alternative A—No Action (Existing CBM Management)

Alternative A has the least impact to cultural resources of all alternatives since this alternative has the least amount of surface and subsurface disturbance. Approximately 17 cultural resource sites would be identified by all projected CBM activities in state and BLM planning areas. An estimated four sites would be impacted from exploration activities in state planning areas; six sites would be impacted from production activities at CX Ranch; and seven would be impacted from exploration activities in BLM planning areas. One or two of these identified sites could be found eligible for the National Register of Historic Places. There would be no production activities in BLM planning areas under this alternative and therefore no impacts from production.

Crow Reservation

Impacts to the Crow Reservation are not expected because no exploration wells are planned for installation on the Reservation at this time. However if exploration wells were to be drilled on the Reservation the likelihood of site impacts would occur at a similar frequency as described for Cultural Resources in general though there could be an increase in cultural resource sites identified because of the increased number of possible TCPs.

Northern Cheyenne Reservation

Impacts to the Northern Cheyenne Reservation also are not expected at this time because the Northern Cheyenne have not indicated that exploration wells would be drilled. As with the Crow Reservation, it is anticipated that when and if the Northern Cheyenne explore their Reservation for CBM resources cultural sites would be encountered on the same regularity as described for Cultural Resources in general. It is conceivable that the density of cultural sites would be increased on the Reservation because of the increased possibility of TCPs. It is assumed that the Tribe would be involved in all surveys and site inspections on the reservation. Therefore, the incidents of cultural resource impacts could be minimized, and possibly avoided altogether.

Conclusion

Over the next 20 years, disturbances from CBM development, conventional oil and gas development, and other cumulative effect analysis project activities could identify 4,285 cultural resource sites of which 430 to 612 could be eligible for the National Register. Impacts from surface disturbance would be minimized by using existing disturbances where possible, and by allowing aboveground utility lines. The impacts from erosion as a result of surface discharge of produced water at CX Ranch would be negligible because of the conveyance systems used to transport the relatively small amount of discharged water. The mitigation measures would be the same as those discussed in Chapter 2. However, given the number of acres likely to be disturbed by all anticipated CBM development, it is unlikely that it would be necessary to mitigate sites or cultural properties through data recovery. In almost all situations, direct impacts to cultural properties would be avoided by relocating well sites or pipelines. Monitoring may indicate sites adjacent to the development fields are being indirectly affected by vandalism and other types of indirect impacts in which case data recovery would be the preferred mitigation. Consultation with tribes may indicate the presence of TCPs that would have to be avoided or which would require alteration of the well field plan in order to mitigate impacts to TCPs.

These are the best estimates of cultural resources that can be derived at this level of study. It is understood that sites occur in clusters based on a host of various criteria (location to water, slope, view, predominate wind, etc) and that some sites are more important than others. A cultural resource location and significance model would be an important and useful tool to help identify areas of critical concern.

Alternative B—Emphasize Soil, Water, Air, Vegetation, Wildlife, and Cultural Resources

Under this alternative, an estimated 629 cultural resource sites would be identified by all projected CBM activities in state and BLM planning areas. Of these sites, 119 to 170 could be found eligible for the National Register of Historic Places. An estimated 16 sites would be impacted by exploration activities in state planning areas, 335 sites from production activities in state planning areas, 10 sites from exploration activities in BLM planning areas, and 269 sites from production activities on BLM planning areas.

Crow Reservation

Impacts on the Crow Reservation would be minimal because no development is anticipated on the reservation at this time. Disturbance totals include TCPs that would be identified off reservation and impacted from the above mentioned activities.

Northern Cheyenne Reservation

There would be no impacts to the Northern Cheyenne Reservation based on commercial CBM development within the region. Disturbance totals include TCPs that would be identified off reservation and impacted from the above mentioned activities.

Conclusion

Over the next 20 years, disturbances from CBM development in state, BLM, Native American, and USFS planning areas; conventional oil and gas development; and surface coal mining activities would identify approximately 5,135 cultural resource sites. Of those sites 515 to 735 would be eligible for the National Register. These totals include traditional cultural properties that would be identified and impacted from the abovementioned activities. The requirement of transportation corridors, one-way in-and-out roads, and the prevention of surface discharge of produced water would help to minimize the number of cultural resource sites impacted. The mitigation measures would be the same as those discussed in Chapter 2.

Alternative C—Emphasize CBM Development

Under this alternative, impacts to cultural resources would be similar to Alternative B with the following exceptions: transportation corridors are not required, thereby increasing the number of disturbed acres and the likelihood of identifying more sites; discharge of produced water directly to the ground surface would increase erosion and site disturbance; power lines may be aboveground or buried, which would decrease the number of disturbed acres. The estimated number of cultural site identified under Alternative C would total 629, with 119 to 170 of these sites being found eligible for the National Register of Historic Places.

Crow Reservation

There would be no impacts to the Crow Reservation from commercial CBM development in the region.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be minimal based on the off-reservation development and avoidance practices employed.

Conclusion

Cumulative impacts would be similar to Alternative B with some exceptions. The surface disturbance from roads and utilities would be greater because one-way in-and-out roads and transportation corridors would not be required. Cultural resource inventories would need to be conducted along the surface watercourses. Surface discharge of produced water would result in increased erosion. The discharge of produced water to the surface would increase erosion and cause increased surface disturbance. The increased surface disturbance would be in the area near the production area, and in the downstream segments of perennial streams and valleys leading to the major surface waters. Further discussion of erosion and the disturbances to soils can be found in the Soils section of this chapter. Mitigation measures would be similar to Alternative B with some exceptions. Mitigation measures would include the use of piping instead of discharging waters into drainage ditches in order to minimize erosion.

Alternative D—Encourage Exploration and Development While Maintaining Existing Land Uses

Under this alternative, impacts to cultural resources would be similar to Alternative B.

Crow Reservation

There would be no impacts on the Crow Reservation or to Crow cultural resources from commercial CBM development within the region.

Northern Cheyenne Reservation

There would be no impacts to Northern Cheyenne cultural resources on the Reservation from off-reservation CBM development. Off-reservation TCPs may be impacted in some locals but avoidance and early identification should eliminate any important sites from being disturbed.

Conclusion

Cumulative impacts would be similar to Alternative B. Mitigation measures would be the same as for Alternative B.

Alternative E—Preferred Alternative

Under this alternative, the impact to cultural resources would be similar to Alternative B with the following exceptions: the removal of an inactive buffer zone around active coal mines and reservations would increase the potential acreage for CBM development and hence potentially increase the number of cultural resources encountered; there might be a decrease in the number of well pads built since operators would be able to use vertical wells for deep coal seams; transportation and utility corridors are not required, thereby increasing the number of disturbed acres and hence encountered sites; power lines may be aboveground or buried, which should decrease the number of disturbed acres in most areas.

The operator's project plan would help develop a survey identification strategy and increase the likelihood of site identification and implementation of mitigation measures. The estimated number of cultural sites identified under Alternative E would total 629, with 119 to 170 of these sites being found eligible for the National Register of Historic Places. Additional cultural site could be found as a result of cultural resource inventories conducted before beginning surface disturbing activities. Locating cultural resource sites would result in the accumulation of additional artifacts and information.

Crow Reservation

No cultural resources would be impacted on the Crow Reservation from commercial CBM development off-reservation lands. With regards to off-reservation TCPs, the BLM has developed specific mitigation measures for protecting Native American sites. These measures will reduce the potential impacts to these off-reservation sites and will help in the avoidance and collection of important artifacts.

Northern Cheyenne Reservation

No cultural resources would be impacted on the Northern Cheyenne Reservation from commercial CBM development off-reservation lands. With regards to off-reservation TCPs, the BLM has developed specific mitigation measures for protecting the Northern Cheyenne's culturally important sites. These measures include provisions for information sharing, and for the prevention of impacts to Northern Cheyenne homestead sites, traditional plant gathering sites, important hunting and fishing locations, culturally significant springs, grave sites, and human remains.

With these specific measures in place to mitigate impacts to Northern Cheyenne culturally important sites and with the BLM committed to providing technical assistance to the Tribe in inventorying, recording, and evaluating cultural sites, it is plausible that impacts will be reduced.

Conclusion

Cumulative impacts would be similar to those describe under Alternative B; however, with the implementation of specific Northern Cheyenne and general Native American mitigation measures impacts to off-reservation TCP sites will be reduced and data collection efforts enhanced.

Geology and Minerals

Geology and Minerals
Montana's mineral resources are intimately tied to the complex geologic framework of the state. Locatable minerals and conventional Oil and Gas resources are found throughout the planning area in various recoverable and non-recoverable amounts

Alternative A
No Action (Existing CBM Management)

- Federal:
  - Only minor loss of CBM during testing operations.
- State:
  - Irretrievable commitment of CBM resources from production on state planning areas.
  - Delayed development or expansion of conventional oil and gas, coal mining, and surface mineral mining in minor instances with no interruption to existing activities.

Alternative B
CBM Development with Emphasis on Soil, Water, Air, Vegetation, Wildlife and Cultural Resources

- Federal:
  - Irretrievable commitment of CBM resources from production, magnitude and complexity to reflect increase scale of development.
  - Potential mineral drainage between federal mineral estates and state, fee and tribal developments depending on site-specific conditions.
- State:
  - Increased commitment of CBM resources due to increased level of CBM development.
  - Mineral drainage issues same as for federal.
  - The presence of shallow CBM production could delay certain types of seismic prospecting for conventional oil and gas reservoirs

Alternative C
Emphasize CBM Development

- Federal:
  - Same as Alternative B with minor increase in water drawdown and potential operational interference within and adjacent to coal mines without the 1-mile buffer zone.
- State:
  - Same as Alternative B.
  - Potential mineral drainage between federal mineral estates and state, fee, or Tribal developments depending on site-specific conditions.

Alternative D
Encourage CBM Exploration and Development While Maintaining Existing Land Uses

- Federal:
  - Same as Alternative B.
- State:
  - Same as Alternative B.
  - Potential mineral drainage between Federal mineral estates and state, fee, or Tribal developments depending on site-specific conditions.

Alternative E
Preferred CBM Development Alternative

- Federal:
  - Same as Alternative B with the addition of increased water drawdown and potential operational interference within and adjacent to coal mines without the 1-mile buffer zone.
  - Protection of Tribal CBM from drainage because of resource protection protocols.
- State:
  - Potential mineral drainage between federal mineral estates and state, fee or Tribal developments depending on site-specific conditions.

Assumptions

- Federal oil and gas leases would continue to be issued with standard lease terms and stipulations as identified by BLM. No Surface Occupancy (NSO), Controlled Surface Use (CSU) and Timing Restriction (Timing) stipulations provide protection to other resources from oil and gas lease activities. A detailed listing and description of stipulations are found in the Final Oil and Gas EIS/Amendment (BLM 1992).
- Federal APDs and Sundry Notices would continue to be issued with Conditions of Approval (COAs) as identified by BLM. COAs provide mitigation to minimize or eliminate impacts to other resources or land uses from oil and gas activities. COAs must conform to lease rights and land use decisions.
- BLM would continue to consult with private surface owners before approving oil and gas activities on private surface. Surface owner requirements can be incorporated as COAs.
- BLM would continue to require a copy of a signed agreement between the private surface owner and the CBM operator before approving drilling operations on private surface.
- The Miles City Field Office and the Reservoir Management Group located in the Casper BLM Office would share drainage case information for cases within one mile of the Montana Wyoming state line.
- Other related Assumptions regarding typical CBM operations are found at the beginning of this chapter.

Impacts From Management Common to All Alternatives

The production or drainage of oil and gas results in the irreversible and irretrievable loss of these resources. Oil and gas resources within a lease area can be directly removed by wells located on the lease area or drained by wells located adjacent to the lease when geologic conditions allow. Gas resources are irreversibly and irretrievably lost during venting or flaring operations. The cumulative impact to oil and gas resources would be a reduction in the known amount of these resources.

Existing BLM and State regulations allow for the production of oil and gas in a manner that conserves those resources so they are not wasted. Oil and gas production is guided by well spacing rules, field rules, lease development requirements, and protective agreements such as communitization and unitization agreements. Flaring and venting operations must be conducted in accordance with agency approval, which also seeks to limit the wasting of gas resources as well as minimizing air quality and safety impacts.

CBM development in Wyoming would result in drainage to Montana lands by wells just across the state boundary. The 80-mile-wide belt of the Powder River Basin that is prospective for CBM would represent approximately 320 1/4-by-1/2-mile (80-acre) spacing units draining resources (gas) from the adjacent state. Hydrocarbon (including CBM) drainage is mitigated by regulations contained in 43 CFR Parts 3100, 3106, 3108, 3130, and 3160. These regulations are meant to avoid waste and protect correlative mineral rights. Regulatory mechanisms include communitization agreements, protection well demands, and compensatory royalties.

Oil and gas development would impact strippable coal resources in areas adjacent to existing coal mines or in new areas of coal mine interest. Oil and gas well bores and the production infrastructure would prevent the mining of coal in areas of oil and gas production.

BLM-issued oil and gas leases are issued with an NSO stipulation in an area with an active federal coal lease and an approved mine plan. The NSO stipulation prohibits surface occupancy and use for oil and gas lease operations. In areas outside of approved mine plans, BLM may issue both coal and oil and gas leases on the same parcel of land. BLM regulations support approval of applications from the first lessee, but also require lessees to resolve conflicts. Resolution of conflicts is further guided by BLM Instruction Memorandum WO-IM-2000-081 (BLM 2002c).

Conventional oil and gas lease operations would not impact CBM resources because of the geology and well bore requirements. Migration of conventional oil and gas from source reservoirs to coal seams usually does not occur because the geology includes an impermeable layer(s) between the hydrocarbon bearing formations and the coal seams. The BLM and State require well bores to be completed with steel casing and cement in key locations of the well annulus to prevent the migration of fluids and drastically reduce the migration of hydrocarbons from one formation to another formation.

Conventional oil and gas wells and the associated infrastructure could be located on a lease area with CBM wells and associated infrastructure.

Sand, gravel, or scoria needed for lease operations can be removed from BLM land by the operator from areas disturbed by lease operations under authority of the lease. Removal of sand, gravel, or scoria from BLM surface by the operator outside of the area of disturbance for lease operations or removal by a third party would require a separate permit approved by BLM.

Impacts From Management Specific To Each Alternative

Alternative A—No Action (Existing CBM Management)

Under this alternative, CBM production would be limited by the number of wells that can be permitted for CBM production by BLM and the State. The total number of producing CBM wells is limited to 250 by the terms of the Settlement Agreement affecting the State. The constraint is in place until the State has completed an EIS addressing the impacts from CBM field development throughout the state. BLM is not approving the production of CBM from federal wells until completion of the EIS, which addresses the impacts from CBM field development in the Powder River and Billings RMP areas.

The production and venting of CBM during the testing phase represent an irretrievable loss of that resource. Under the existing situation, CBM may be drained from federal lands by producing CBM wells on private and state leases. This drainage of federal CBM represents an irretrievable loss of that resource. The venting of CBM during coal mining represents the irretrievable loss of the resource.

Expansion of the Decker coal mine to the west and south, and expansion of the Spring Creek coal mine to

the south would be constrained by CBM wells and the associated infrastructure of the CX Field. Mine expansion could occur after abandonment of the CX Field and removal of facilities and equipment.

Removal of groundwater by CBM wells in coal seams that are being mined by Decker and Spring Creek could reduce the amount of groundwater flowing into the mine areas. Reduction in the amount of groundwater or degradation of groundwater quality by CBM production would reduce the amount of groundwater available for domestic water wells from a particular coal seam. CBM could migrate to domestic wells or escape at the surface from the removal of groundwater for CBM production.

The presence of CBM wells and the associated infrastructure could prevent certain types of seismic operations from being conducted in the area of CBM production. The use of explosives could damage well bores or surface equipment, and could damage the upper coal seam used for CBM production.

Crow Reservation

Producing CBM wells located within 1 mile of the Crow Reservation boundary could drain CBM resources from the Reservation. This drainage of Indian owned or privately owned CBM would represent an irretrievable loss of the resource and a loss of royalties to the mineral owner. The location of CBM wells and associated infrastructure on private and state lands could influence the location of future CBM wells and associated infrastructure on lands within the Crow Reservation. This scenario is not anticipated under Alternative A because of the State Settlement Agreement.

A detailed description of potential drainage impacts to Crow resources is found in the *Environmental Justice* section, and a detailed description of potential impacts to groundwater from drawdown by CBM wells is found in the Hydrology section.

Northern Cheyenne Reservation

It is not anticipated that any producing CBM wells would be located within 1 mile of the Northern Cheyenne Reservation boundary and therefore drainage of Tribal CBM resources from the Reservation is not anticipated.

Conclusion

The production of CBM by state and private wells and the venting of CBM represent the irreversible and irretrievable loss of the resource. The restrictions on the total number of CBM wells approved for production reduces and delays associated revenues to lessees and government. The venting of CBM during coal mining represents the irreversible and irretrievable loss of the resource.

Production of CBM should not impact the geology of the production area or any conventional oil and gas in the area of CBM production. CBM wells and the associated infrastructure would hinder the expansion of the Decker and Spring Creek coal mines toward the CX Field. The production of CBM would not prohibit the production of conventional oil and gas resources from the area of CBM production. The production of conventional oil and gas in or around the CX Field would increase and intensify the impacts to other resources and on land uses.

The mitigation measures for this alternative would be similar to those described in Chapter 2.

Alternative B—Emphasize Soil, Water, Air, Vegetation, Wildlife, and Cultural Resources

Under this alternative, the types of impacts experienced would be similar to those described under Alternative A, but increased because of expanded CBM production on state, fee, and BLM oil and gas lease areas. The increased development as part of this alternative would result in more CBM production and the irretrievable commitment of more resources. Increased CBM production would amplify the opportunity for methane drainage from adjacent leases. Under this alternative, multiple coal seams would be developed from a single well bore. All coal seams would be developed at the same time and directional drilling for deeper coal seams would be required.

This alternative also includes a 1-mile buffer zone around active coal mines that would minimize the operational interference and water drawdown impacts from nearby CBM production. Production of CBM would not be authorized on federal leases within a 2-mile buffer zone in Montana along the Reservation boundary. The state may allow production of CBM from state leases within the buffer zone. The prohibition on the production of CBM within the buffer zone would not apply to fee leases within the buffer zone.

The drawdown of groundwater from coal seams would not damage the coal resource present through compaction, nor would the likelihood of coal seam fires be greater than before. The circumstances for self-ignition of coal would not be present in the direct

vicinity of CBM wells in the emphasis area. During the production stage of CBM activity, conditions essential to cultivate spontaneous combustion of coal such as oxidation, heat of wetting, airflow rate, coal particle size, pyrite content and temperature are not present. In fact, the design and construction of CBM wells efficiently vents heat out of the coal so that temperatures needed for coal ignition are neither present nor anticipated.

After the coal seam is exhausted of methane resources, wells must be plugged and sealed. Unlike abandoned mines, CBM wells leave no underground voids vulnerable to further subsidence and associated spontaneous coal ignition. The probability of completely dewatering a coal bed and revealing large areas of fine coal particles to oxygen seem exceedingly remote (Lyman and Volkmer 2001). Further discussion regarding groundwater issues is contained in the *Hydrology* section of this chapter.

The presence of CBM wells and the associated infrastructure could prevent certain types of seismic operations from being conducted in the area of CBM production. The use of explosives could damage well bores or surface equipment and could damage the upper coal seam used for CBM production.

The drawdown of groundwater from CBM activities has been identified as the cause of surface subsidence in Wyoming (Case et al. 2000). The subsidence was recorded as 1/2 inch and therefore, does not represent an immediate impact to surface lands. In Montana where coal seams are thinner, subsidence would be less than what has been observed in Wyoming where coal seams are thicker.

Crow Reservation

Impacts to mineral resources on the Crow Reservation would be the same as described above in this alternative. Producing CBM wells located within 1 mile of the Crow Reservation boundary could drain CBM resources from the Reservation. This drainage of Indian owned or privately owned CBM would represent an irretrievable loss of the resource and a loss of royalties to the mineral owner. The location of CBM wells and associated infrastructure on private and state lands could influence the location of future CBM wells and associated infrastructure on lands within the Crow Reservation. Expanded CBM development activities would increase the impacts and extraction of Tribal CBM resources.

Northern Cheyenne Reservation

Impacts to mineral resources on the Northern Cheyenne reservation would be the same as described above in this alternative. Producing CBM wells located within 1 mile of the Northern Cheyenne Reservation boundary could drain CBM resources from the Reservation. This drainage of Indian owned or privately owned CBM would represent an irretrievable loss of the resource and a loss of royalties to the mineral owner. The location of CBM wells and associated infrastructure on private and state lands could influence the location of future CBM wells and associated infrastructure on lands within the Crow Reservation. Expanded CBM development activities would increase the impacts and extraction of Tribal CBM resources.

Conclusion

One of the cumulative impacts from this alternative would be increased production of CBM from an increased number of producing wells including Tribal wells and from multiple coal seam development simultaneously. Multiple coal seam development simultaneously would result in the production of CBM occurring more quickly than single seam development. Along with venting of CBM during well testing, this would represent an irreversible and irretrievable loss of the resource.

The increased number of producing CBM wells and the associated infrastructure could inhibit the expansion of existing coal mines, even with the 1-mile buffer zone. This would delay or possibly preclude the mining of coal in certain areas. Areas of new coal mine interest would be excluded from opening new coal mines by the existence of producing CBM wells and infrastructure.

The mitigation measures for this alternative would be similar to those described in Chapter 2. Additional mitigation measures include buffer zones around existing coal mines and simultaneous production of multiple coal seams through single well bores, subsurface injection of untreated water produced with CBM, and maximizing the number of producing CBM wells connected to field compressors.

Alternative C—Emphasize CBM Development

Under this alternative, CBM production could occur on state, fee, and BLM lease areas. Operators would not be required to produce CBM simultaneously from multiple coal seams through a single well bore. CBM

production from multiple coal seams could occur simultaneously through single well bores or simultaneously through separate well bores or different coal seams could be developed separately (staggered over time) or a combination of production methods.

Allowing CBM production from state, fee, and BLM leases would increase the amount of CBM produced. Producing CBM from multiple coal seams simultaneously would have impacts similar to those described in Alternative B. Producing CBM from single coal seams would have similar impacts, but would extend the length of time for production. The potential for drainage of CBM resources by producing CBM wells would increase with the increase in the number of producing wells. Directional drilling would not be required. Without directionally drilled wells, the impacts from vertical wells would be the same as Alternative A but increased for the scale of development.

CBM production will impact adjacent coal mines by increasing coal bed aquifer drawdown and by interfering with expansion of existing coal mines. The added dewatering from CBM operations would affect the coal mines by hindering and complicating aquifer restoration efforts the mine must perform once mining activities cease. In addition, the removal of coal seam water may create a situation where some coal mines would need to purchase water for dust control.

The drawdown of groundwater does not represent an immediate impact to surface lands resulting from subsidence. The thinness of the coal seam aquifers and their shallow depth should prevent them from being substantially impacted by groundwater withdrawal and subsequent aquifer compaction.

Crow Reservation

Impacts on the Crow Reservation would be the same as described for the study area in general for Alternative C. However, without the 2-mile Reservation buffer zone, Tribal CBM resources would have an increased vulnerability to drainage from adjacent state, federal, and private wells.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the study area under this Alternative. Furthermore, without the 2-mile Reservation buffer zone, Tribal CBM resources would have an increased vulnerability to drainage from adjacent state, federal, and private wells.

Conclusion

The cumulative impacts for this alternative would be similar to Alternative B with some exceptions. The removal of the requirement for a buffer zone around coal mines would result in increased drawdown and greater operational interference within the mines from CBM production. After mining has ceased, the added dewatering will need to be remediated by the mine operators. Remediation bonds executed by the mine operators prior to operations will need to be honored. Unless the impact of the CBM production can be separated from impacts by the coal mine, the remediation bond will force the mine operator to spend more money to remediate the aquifer. Coal mine operators may develop aquifer mitigation agreements with CBM operators prior to CBM production. The mitigation measures for this alternative would be similar to Alternative A.

Tribal development of CBM resources on reservations would increase the irreversible and irretrievable loss of the resource.

Alternative D—Encourage Exploration and Development While Maintaining Existing Land Uses

Impacts from management objectives outlined in Alternative D would be similar to the impacts described under Alternative B.

Crow Reservation

Impacts to the Crow Reservation would be similar to impacts described in Alternative B.

Northern Cheyenne Reservation

Impacts to the Northern Cheyenne Reservation would be similar to impacts described in Alternative B.

Alternative E—Preferred Alternative

Impacts to coal and existing coal mines would be the same as Alternative C because a buffer zone would not be required around existing coal mines.

Impacts to CBM resources would be the same as Alternative B if all coal seams are produced simultaneously or to Alternative C if coal seams are produced separately. Impacts to CBM production and wells would be the same as Alternative A because multiple seam production through a single well bore would not be required.

Impacts on conventional oil and gas resources would be the same as discussed in the *Management Common* section.

The production of CBM and the venting of CBM represent the irreversible and irretrievable loss of the resource. Drainage by off-lease CBM wells represents the irreversible and irretrievable loss of the resource and royalties to the lessee of the lease being drained.

For Alternative E, the Crow and Northern Cheyenne Reservation would be protected from drawdown of coal seam aquifers and drainage of tribal CBM resources as described in Chapter 2 of this document. To gauge incipient impacts related to groundwater and CBM resource drainage on the Crow and Northern Cheyenne reservations, monitoring wells would be required to be installed during the exploration phase on all BLM-administered oil and gas leases that show hydrologic connectivity with the reservation aquifers.

Crow Reservation

Impacts to the Crow Reservation from federal lease operators under Alternative E would be minimized. A buffer zone would not be established around the borders of the Reservation. However, other mitigation options would be available for consideration by the Tribes. These include reducing production rates, shutting in the well or wells, payment of compensatory royalties, establishment of communitization agreements, or spacing to protect reservation CBM resources from drainage. Under this alternative, there would be no drainage of tribal CBM resources by federal lease operators. The potential for drainage by fee lands within the reservation boundary and along the exterior boundary would still exist.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation from federal lease operators under Alternative E would be minimized. A buffer zone would not be established around the borders of the Reservation. The BLM has the responsibility to use reasonable means to prevent drainage of Tribal CBM caused by development on federal lands. Operators would be required to provide site-specific analyses prior to field development in areas of potential drainage to Tribal CBM resources. In these analyses, operators must demonstrate whether and to what extent federal CBM production is likely to drain Reservation CBM. The analysis would be used by BLM to determine the timing of CBM production, monitoring requirements, and additional data needs.

If monitoring or reservoir modeling indicates drainage of CBM resources is occurring, the BLM would enter negotiations with the operator and the Tribe to protect the correlative rights of the Tribe. BLM requirements could include reducing production rates, shutting in the well or wells, establishment of communitization agreements, or payment of compensatory royalty.

To protect the correlative rights of the Tribe from state and private CBM development, the BLM would represent the Tribe at MBOGC hearings that set spacing units for the production of CBM resources including state and private lands. The BLM would work with the MBOGC under its existing Memorandum of Understanding to protect Tribal resources that may be affected by state or private permits, or establishment of CBM spacing units adjacent to Tribal resources. Under this alternative, there would be no drainage of tribal CBM resources by federal lease operators. The potential for drainage by fee lands within the reservation boundary and along the exterior boundary would be minimized to the extent possible.

Conclusion

Under this alternative, cumulative impacts would be similar to Alternative B with the exception that injection of produced water would not be required. Injection of produced water into a subsurface formation approved by the state would be one water management option available to operators under this alternative and such disposal would not impact other mineral resources. Other produced water management options would be making produced water available for beneficial uses and treating, as needed, produced water before being discharged onto the surface or into bodies of water or used in land applications. Impacts from produced water management options are described in other resource sections, such as hydrology and soils.

Hydrological Resources

Hydrological Resources

Surface water: Some surface waters in the Powder River Basin are of good quality and frequently used for irrigation. Other Rivers are characterized as having fair to poor quality water and may go dry, the waters are used for stock and limited irrigation.

Groundwater: Groundwater is available in stream bottom alluvium, but becomes scarce away from water courses. Coal beds and interlayered sands are the most commonly used aquifers away from riparian areas. Groundwater quality is variable.

Alternative A
No Action (Existing CBM Management)

- Federal:
  - No impacts to surface or groundwater resources
- State:
  - Negligible changes in Tongue River quality and flow.
  - Groundwater drawdown within the immediate vicinity of the CX Ranch
  - Continued beneficial reuse of produced water at the CX Ranch
- Cumulative Impacts:
  - Surface Water:
    Wyoming CBM discharges will result in slight increases in flow and slight changes in water quality in rivers shared between Montana and Wyoming, however downstream uses will not be diminished
  - Groundwater:
    Drawdown from Wyoming CBM and the CX Ranch may extend several miles from development.
  - Beneficial Reuse:
    Wyoming and CX Ranch discharges may increase opportunities for beneficial use.

Alternative B
CBM Development with Emphasis on Soil, Water, Air, Vegetation, Wildlife and Cultural Resources

- Surface Water
  - Same as Alternative A.
- Groundwater:
  - Drawn down will occur over large continuous areas
  - Immediate drawdown will be minor. However, as CBM production matures, coal seam aquifer drawdown may extend 4 to 5 miles from the edge of production
  - No change in groundwater quality
- Beneficial Reuse:
  - Same as Alternative A
- Cumulative Impacts:
  - Surface water flow and quality will be the same as Alternative A
  - Montana CBM production and Wyoming will noticeably drawdown coal seam aquifiers
  - Groundwater quality in Montana and beneficial reuse will be the same as Alternative A

Alternative C
Emphasize CBM Development

- Surface Water
  - Water quality in some watersheds will be noticeably altered.
  - Flows will be considerably increased.
- Groundwater:
  - Drawdown similar to Alternative B.
  - Alluvial groundwater quality may be altered due to infiltration of untreated production water
- Beneficial Reuse:
  - Same as Alternative A
- Cumulative Impacts:
  - Surface water quality in some watersheds will be noticeably altered.
  - Flows will be considerably increased.
  - Impacts to groundwater drawdown, quality and beneficial reuse will be the same as in Alternative B

Alternative D
Encourage CBM Exploration and Development While Maintaining Existing Land Uses

- Surface Water
  - Water quality will not be altered.
  - Flows will increase similar to Alternative C
- Groundwater:
  - Drawdown same as Alternative B
  - No groundwater quality impacts
- Beneficial Reuse:
  - Increased beneficial uses, estimated at 20% of production
- Cumulative Impacts:
  - Surface water quality will be slightly altered due to Wyoming CBM discharges.
  - Surface water flows will be similar to Alternative C
  - Groundwater drawdown and quality changes will be the same as in Alternative B

Alternative E
Preferred CBM Development Alternative

- Surface Water
  - Water quality will be slightly altered, however beneficial uses will not be diminished
  - Flows will moderately increase
- Groundwater:
  - Drawdown same as Alternative B.
  - Alluvial groundwater quality may be altered due to infiltration of untreated production water
- Beneficial Reuse:
  - Required Water Management Plans from all operators will result in Beneficial reuse of approximately 20% of production
- Cumulative Impacts:
  - Cumulative impacts will be dependent on MDEQ numerical standards
  - Surface water quality will be slightly altered however downstream uses will not be diminished
  - Surface water flows will be moderately increased
  - Groundwater drawdown will be similar to Alternative B
  - Shallow groundwater quality may be slightly altered

The key water quality parameters for predicting the potential effects of CBM development on irrigated agriculture are sodicity (as sodium adsorption ratio, SAR) and salinity (as electrical conductivity, EC). The MDEQ believes that irrigated agriculture is the most sensitive beneficial use for surface waters in the study area, thus protection of irrigated agriculture will also be sufficient to protect all other beneficial uses. Instream numerical targets for these parameters are used to model environmental impacts.

Ideally, those numerical targets could be compared to numerical water quality standards. However, there are no final, numerical water quality standards for these parameters applicable to the waterbodies addressed in this EIS. The regulatory entities with jurisdiction (MDEQ, EPA, and the Northern Cheyenne Tribe) for the potentially affected waterbodies have begun the process of quantifying the SAR and EC values they believe would protect irrigated agriculture in these basins.

In May 2002, the Northern Cheyenne Tribe adopted numerical water quality standards for SAR and EC applicable to waters within the Reservation. Although these tribal standards do not have Clean Water Act regulatory status until approved by the EPA, the adopted numerical standards do set out the Tribe's considered determination of the water quality needed to protect irrigated agriculture on the Reservation (Northern Cheyenne Tribe 2002).

The State of Montana has initiated a process for developing and adopting water quality standards for SAR and EC. Within the Montana process, MDEQ has proposed two approaches: one approach would assign a single set of SAR and EC values to each of the potentially affected waterbodies (Option 1) and the second approach would assign a series of values applicable to specific segments of those waterbodies (Option 2). For each approach, the MDEQ lists a range of values that might be considered by the Board of Environmental Review.

In addition, within the Montana process, a coalition of environmental and irrigation interest groups, collectively known as the "Petitioners," has proposed its own set of numerical SAR and EC standards. The Petitioners' proposal takes an approach similar to the MDEQ's option 2. The Petitioners include the Tongue River Water Users Association, the Tongue and Yellowstone Irrigation District, the Buffalo Rapids Irrigation Project, and the Northern Plains Resource Council.

Therefore, four sets of numerical standards for SAR and EC are now under consideration for applicable to the waterbodies addressed in the EISs: the Northern Cheyenne Tribe's adopted water quality standards; Montana's Option 1; Montana's Option 2; and the proposed standards of the Petitioners. Together, these four sets of values present a wide range of numerical values, and are shown in Table 4-18.

Table 4-18 summarizes the highest and lowest limits proposed by the petitioners to the Montana DEQ standards process. The proposed limits apply to individual watersheds and have been suggested for seasons of the year. For example, different limits have been proposed for the irrigation season but since a single irrigation season has not been agreed upon, the limits have been lumped together. The proposed limits are fully summarized in the Hydrology Appendix.

Because the water quality standards development process is still underway for key waterbodies addressed by the EISs, it would be inappropriate for the lead or cooperating agencies to select specific numerical values within the range of proposals and to apply only those selected values in evaluating potential impact scenarios. Instead, the full range of proposed SAR and EC limits are compared with the modeling outputs. The information is presented so that the reader may compare any discharge alternative with the proposed SAR and EC values.

When evaluating the various SAR and EC values, consider the following points:

- It should not be assumed that any SAR or EC value within the displayed range will eventually be determined to provide an appropriate level of protection for the existing or anticipated irrigated agricultural uses in these basins.
- The water quality standards process involves adoption by a state or Tribe, followed by EPA review and approval, and it is important to note that state- or Tribally-adopted standards would not have Clean Water Act regulatory meaning until approved by EPA.

TABLE 4-18
SUMMARY OF PROPOSED LIMITS FOR MONTANA SURFACE WATER

Stream	Most Restrictive Proposed Limit (MRPL)		Least Restrictive Proposed Limit (LRPL)	
	SAR	EC	SAR	EC
Tongue, Little Bighorn, and Bighorn, Yellowstone	0.5	500	10.0	2500
Rosebud	1.0	500	10.0	2500
Little Powder	3.0	1000	10.0	3000
Powder	2.0	1000	10.0	3200

- The water quality standards process is still underway, and it is not possible to predict the outcome of that process.

While the eventual outcome of this water quality standards process is uncertain, it is useful to note the specific SAR and EC values contained in Table 4-18. The values shown in Table 4-18 were determined from all of the proposed standards currently before the Montana Board of Environmental Review. A complete listing of the proposed standards is located in the Hydrology Appendix of this EIS. These SAR and EC values were developed with assistance from advisors with expertise in the area of salinity and sodicity effects on irrigated agriculture. Therefore, it would not be unreasonable to view these values as providing a fair estimate of the range of SAR and EC values that may eventually be judged as providing an appropriate level of protection for irrigated agriculture in these basins.

The Ayers and Westcot EC/SAR relationship is used to determine the effect of irrigation waters on the infiltration capacity of soils. This relationship recognizes that as salinity increases the potential impacts of SAR decrease. This relationship is not unbounded, however, because of the potential impact of rainfall on sodic soils. Rainfall can cause SAR problems in surface soil because of the differential way in which EC and SAR respond to a rain event (significant lowering of the EC and little change in the SAR). This rain-on-sodic-soil problem is addressed in a number of the standards proposals (see Hydrology Appendix) through adoption of an absolute maximum SAR (i.e., the standard "caps" the Ayers and Westcot EC/SAR relationship).It will be important to be mindful of an upper bound on the Ayers and Westcot relationship in reviewing the conclusions reached in the alternatives analyses in this document. This may help explain situations where the MRPL (or perhaps, the LRPL) shows a potential effect, where the Ayers and Westcot diagram indicates no reduction in infiltration. This relationship is used as criteria against which the results of the surface water quality are compared.

Another factor to consider in applying these SAR and EC values is that there is a significant distinction to be made between the modeling approach applied to alternatives analysis and the approach that eventually will be used in calculating discharge limits for future, specific CBM projects:

- The modeling approach used in this document begins with an assumed water management method for all the reasonably foreseeable CBM development in Montana and Wyoming and, applying a series of assumptions (see discussion below), predicts a resultant instream cumulative water quality. That predicted water quality modeling output is then displayed against the full range of proposed SAR and EC limits, with no assessment as to the appropriateness of any specific value within that range.

- The water quality-based approach that is actually used to calculate future Montana Pollutant Discharge Elimination System (MPDES) permitting requirements will begin with appropriate and specific instream water quality standards. Through the total maximum daily load (TMDL) process, those standards will be translated into discharge limits for specific CBM projects.

The standards serve as the regulatory basis for controlling CBM discharges, and the water quality-based permitting approach that implements these standards is different from the predictive modeling approach used in this EIS.

The water quality-based approach begins with a desired instream water quality and, using that as the target, calculates the CBM discharge limits needed to ensure the desired instream water quality is achieved. The TMDL process identifies capacity for a waterbody to assimilate substances (maximum load). That capacity then has to be allocated among the appropriate governmental entities along that waterbody. It should be noted that, where a Tribe is one of the appropriate governmental entities, EPA has a trust responsibility to ensure a fair and meaningful portion of the available assimilative capacity is reserved for that Tribe.

The spreadsheet model used in the analysis of impacts for the EIS employs a steady state mass balance approach to estimate concentrations of EC and SAR after stream water and CBM discharged water are mixed. The steady state mass balance approach is commonly used by the EPA in predicting possible effects of point source discharges on receiving waters. Input parameters to the spreadsheet model were developed from analysis of reasonably conservative assumptions, as well as measures of central tendency (typical or mean values).

The Surface Water Quality Analysis Technical Report (SWQATR) lists the input parameters and indicates whether conservative or mid-range values were used in the impact analysis model. The resultant spreadsheet model is considered to provide a conservative, yet reasonable estimate of the impacts of CBM development on surface water quality in the Powder River Basin. The SWQATR also discusses the problems of manipulating sample SAR values (Greystone 2002). It should be noted that this model is meant to be used to compare alternatives, not to predict precise resultant water quality.

Assumptions

CBM development has the potential to impact surface water, surface aquifers, and coal seam aquifers that hold the groundwater resources in the planning and CBM emphasis area. The following assumptions form the framework for analyzing the impacts:

- The maximum volume of CBM water production and discharge is predicted to occur in year 6 of the RFD. All surface water impacts are calculated using this maximum CBM discharge volume.
- All modeling results shown in this EIS are for the low mean monthly stream discharges. 7Q10 discharges are also included in the SWQATR analysis.
- SAR and EC were calculated using a simple flow-weighted mass balance equation. This assumption is strictly correct for EC however it results in an overestimation of SAR. This results in a conservative model of impacts due to CBM discharges.
- To facilitate analysis, a range of water quality criteria is assumed based on the proposals before the Montana Board of Environmental Quality. The states of Wyoming and Montana recognize public concern and, in an effort to protect the water quality within the Powder River Basin, have entered into an 18-month interim memorandum of cooperation. A copy of the interim memorandum of cooperation can be found in the Hydrology Appendix. The interim memorandum of cooperation is intended to specifically protect the downstream quality of the Powder and Little Powder watersheds that enter Montana from Wyoming. The criteria for EC are expressed in monthly maximum values that are not to be exceeded. The two states are also concerned with SAR and bicarbonate, but lack sufficient data. For the Little Powder River, monitoring of the EC, SAR, and TDS will be performed by the state of Montana to determine if these levels change appreciably.

A complete listing of all model assumptions may be found in the SWQATR.

Impacts From Management Common to All Alternatives

Conventional Oil and Gas Production

Conventional oil and gas production can produce large volumes of water that could impact surface and groundwater resources because of the quality of the produced water. Since 1953, the MBOGC has regulated the use and disposal of water produced in association with the production of oil and natural gas to mitigate the potential for impacts to the environment.

The use of surface impoundments is controlled by BLM and the state. BLM permits water disposal pits (surface impoundments) on federal leases. The permitted surface impoundments are those designed primarily for evaporation. Any impoundments

constructed in the state, including those involving federal land or minerals, would require approval from the MBOGC. Further, the MDEQ permits any point-source discharges to surface waters (e.g., streams), including those that could result from surface impoundments.

Conventional oil and gas is typically produced from depths below usable aquifers and below coal seams. Regulations require the isolation of oil and gas producing zones from other reservoirs containing possible hydrocarbons or from aquifers that contain usable water. Underground Injection Control (UIC) regulations also require safeguards to isolate injection zones from other zones that contain hydrocarbons and from aquifers that contain usable, or potentially usable quality water (i.e., groundwater containing less than 10,000 mg/l of total dissolved solids).

Produced water that has a TDS concentration of less than 15,000 mg/l can be discharged to permitted surface impoundments. As a result of the existing regulations, the impact on surface water and groundwater resources from conventional oil and gas production is minimal.

Impacts from Management Specific to Each Alternative

Impacts on Hydrological Resources under the five management alternatives are summarized in Chapter 2, Table 2-3, Comparison Summary of Impacts. The impacts are discussed in detail for the major watersheds in the following sections.

Alternative A—No Action (Existing CBM Management)

Alternative A consists of the existing CBM management scenario, with the addition of the forecast future development of CBM resources in the Wyoming portion of the Powder River Basin that occurs upstream Montana. Based upon discussions with the Wyoming offices of BLM and the WYDEQ, it is assumed throughout this EIS that Wyoming's Alternative 2A will be adopted for Wyoming.

Under Montana's alternative A, only those producing wells that currently exist in the CX Ranch field will produce CBM and water in Montana. Other CBM exploration wells could be drilled on state and fee minerals, but would not be allowed to produce gas or water. Rosebud Creek, the Bighorn River, and Mizpah Creek would not receive any CBM produced water under this alternative, as they would not be affected by Wyoming's production. However, an analysis of their flow volumes and water chemistries are included for comparison to other alternatives. The Tongue River, Powder River, and Little Powder River watersheds could have impacts from CBM development due to Wyoming production.

Exploration

CBM exploration activities on state, fee, or BLM-administered mineral estates would result in only slight effects on groundwater and would not affect surface waters. Exploration wells would be tested but not commercially produced. Testing of CBM exploration wells involves pumping the wells for several weeks; however, the volume of coal seam aquifer groundwater removed is moderate and is not expected to impact nearby water wells or springs. Recovered produced water and drilling wastes would be contained in impoundments or tanks and would be disposed of in accordance with regulations for conventional oil and gas wastes.

Production

CBM water production would continue to be allowed within the CX Ranch CBM field, but at a level approximately 20 percent above current conditions; this would constitute a total of 250 producing wells. An increase in soil erosion resulting from the construction of additional well pads and lease roads could occur, adding to the suspended sediment load of area surface waters.

The 250 producing CBM wells at the CX Ranch field would also affect groundwater resources within the producing coal seam aquifers. Production at this level would result in increases to groundwater drawdown levels within the three coal seam aquifers being produced. Groundwater drawdown within the coal seams currently extends at least 1.8 miles beyond the edge of CBM production at the CX Ranch field. Increasing the size of the field by approximately 20 percent would add to the drawdown.

Two-dimensional groundwater modeling has indicated that drawdown of coal seam aquifers may extend up to 14 miles from the edge of a producing field after 20 years of production (Wheaton and Metesh, 2001). Three dimensional modeling of the East Fork of Hanging Woman Creek, which takes into account vertical leakage, indicates that 20 feet of drawdown in the coal seams would extend 4 to 5 miles from the producing field. (Wheaton and Metesh, 2002). Effects on groundwater could also take the form of dry springs that issue from methane-productive coal seams caused by coal seam aquifer drawdown. Aquifers other than the produced coal seams, such as alluvium or

sandstone bedrock aquifers, are estimated to be less vulnerable to drawdown from CBM production due to low vertical hydrologic conductivity in the Tongue River member of the Fort Union Formation. This will limit the vertical movement of groundwater (Wheaton and Metesh, 2002).

Water released to unlined surface impoundments in alluvial materials has the opportunity to infiltrate into shallow aquifers, causing measured impacts to the depth to water in the alluvial aquifers and alluvial wells. The introduction of this water to the aquifer may improve or degrade the usability of these waters, depending on site specific conditions. Infiltration basins constructed out of drainages and away from outcrops should recharge bedrock aquifers. This recharge is not expected to appreciably alter groundwater chemistry.

Surface Water Analysis

Tongue River

The Tongue River has its headwaters in the Bighorn Mountains to the south. This river could receive CBM impacts from current and future development in both the Wyoming and Montana portions of the Powder River Basin. The detailed input data, calculation of impacts, and summary of impacts from Alternatives can be reviewed in the SWQATR. Table 4-19 displays the impacts for the three stream stations analyzed along the Tongue River in Montana.

The Tongue River is not expected to be impacted by direct CBM water discharges from Wyoming (see WYDEQ memo located in Hydrology Appendix). The Wyoming EIS and this EIS do predict that the Tongue River could be impacted by approximately 15 percent of the produced water volume through accidental releases and through recharge of the river from infiltration into shallow aquifers. In addition, other impacts to the Tongue River under Alternative A could result from the approximately 250 CBM wells in the CX Ranch field. For this analysis, the CX Ranch discharge was split between the Decker station and the Birney station.

During the minimum mean monthly flow, these impacts increase the flow volume and EC value in the stream by only a few percentage points, but increase the SAR value in the river water by up to 133 percent (1.4 units). The resultant mixed stream water and CBM water can be compared to the following surface water criteria:

- Most Restrictive Proposed Limit (MRPL): These limits are set at a SAR of 0.5 and an EC of 500 micro-Siemens per centimeter (μS/cm) for the Tongue River. Since the Tongue River naturally exceeds these limits, it cannot receive any CBM discharge if these limits are adopted. The forecasted impacts under Alternative A are, therefore also in excess of the these proposed limits.

- Least Restrictive Proposed Limit (LRPL): These proposed limits would be set at a SAR of 10 and an EC of 3,000 μS/cm. These limits would not be exceeded during either the Minimum Mean Monthly or the 7Q10 (lowest flow that would be expected for 7 consecutive days over a 10 year period) flows under Alternative A.

- Northern Cheyenne Proposed Standards: Surface water alteration forecasted under Alternative A would be at or below the Tribe's proposed limits during the irrigation season (April through October) but would exceed the proposed standard for SAR during the non-irrigating season by up to 0.52 SAR.

- Ayers and Westcot 1985 water quality plot: The SWQATR displays the SAR versus EC plots for the Tongue River. These plots show that at no time would the water cause infiltration impacts to soils under irrigation under Alternative A.

- The surface water volume and quality in the Tongue River is slightly altered by CBM discharges under Alternative A; however, beneficial uses are not anticipated to be impacted.

Powder River

The Powder River has its headwaters in the Wyoming portion of the Powder River Basin, and as such would receive CBM water from development in Wyoming. As no Montana CBM wells are assumed to discharge into the Powder River under Alternative A, all forecasted alterations would be due to CBM development in Wyoming. The analysis conducted at the Locate, Montana, station includes all CBM discharges into the Powder, Little Powder, and Mizpah, cumulatively. Table 4-20 summarizes these impacts.

The Powder River is expected to be affected by Wyoming CBM development, resulting in an appreciable alteration of surface water chemistry. Only

TABLE 4-19
EFFECTS ON SURFACE WATERS OF THE TONGUE RIVER UNDER ALTERNATIVE A

Station	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity (Min Mean Monthly) Under Alternative A		
	SAR	EC (µS/cm)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)
Tongue River at Stateline Near Decker	0.5	500	10	2500	178	0.86	731	183	1.93	773
Tongue River Near Birney Day School	0.5	500	10	2500	183	1.09	863	190	2.52	912
Tongue River at Brandenburg Bridge Near Ashland, Montana	0.5	500	10	2500	207	1.36	1016	214	2.5	1058

TABLE 4-20
EFFECTS ON SURFACE WATERS IN THE POWDER RIVER UNDER ALTERNATIVE A

Station	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity (Min Mean Monthly) Under Alternative A		
	SAR	EC (µS/cm)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)
Powder River at Moorhead	3	1000	10	3200	145	4.65	2154	224	10.7	2230
Powder River at Locate	3	1000	10	3200	143	4.61	2287	236	11.36	2320

Wyoming CBM development would affect the river. Flow volumes are forecasted to increase by approximately 54 percent SAR would be increased by approximately 130 percent, and EC would be increased by 3 to 4 percent. The resultant mixed stream water quality can be compared to the available surface water criteria:

- MRPL: The Powder River is naturally well above MRPLs for SAR and EC limits. Therefore, it could not receive any CBM discharge if these limits are adopted. The forecasted impacts under Alternative A would render the Powder River even farther in excess of these proposed limits.
- LRPL: EC and SAR limits would not be substantially exceeded except during the lowest flow (7Q10) periods under Alternative A.
- Ayers and Westcot 1985 water quality plot: The SWQATR includes SAR vs EC plots to document that at no time except 7Q10 low flow will the mixed water cause infiltration impacts to soils under irrigation.

The surface water volume and quality in the Powder River would be affected by discharges from Wyoming CBM development under Alternative A. Irrigators currently tend to use Powder River water for irrigation during high flow events. The SWQATR shows that during the irrigation season, the SAR would increase

77 percent and during the non-irrigation season would increase 100 percent. EC would be expected to increase only approximately 4 percent during both the irrigation and non-irrigation seasons at the Moorhead station. Flow would increase approximately 15 percent during the irrigation season and approximately 29 percent during the non-irrigation season. During the 7Q10 flow the Powder River contains very little water, and the water in the river is too saline to be used for irrigation. Therefore these changes in water quality are not expected to impact the current beneficial uses of these waters.

The Little Powder River

The Little Powder River has its headwaters in the Wyoming portion of the Powder River Basin, and as such it is expected to receive CBM water from development in that state. All analyses for this stream are conducted at the Weston, Wyoming, station, near the stateline. At this station, no effects are possible from Montana CBM under any alternative. Table 4-21 illustrates the effects expected on the Little Powder River from CBM development under Alternative A.

Only Wyoming CBM discharges affect the river under this alternative. During minimum mean monthly flows, this development will cause the flow to increase by 515 percent, the EC to decrease by 51 percent, and the SAR to increase by 50 percent. The resultant mixed stream water and CBM water can be compared to the following surface water criteria:

- MRPL: The Little Powder River is naturally above these SAR and EC limits and could not receive additional CBM discharge if these limits were adopted. The forecasted effects under Alternative A renders the stream water farther in excess of these limits.
- LRPLs: EC and SAR limits are exceeded only during the lowest flow periods (7Q10) under Alternative A.
- Ayers and Westcot 1985 water quality plot: The SWQATR plots suggest that during the mean monthly flows for 2 months of the year (November and December), the mixed water may cause infiltration impacts to soils under irrigation. The elevated SAR may reduce soil permeability, thereby reducing the rate of water infiltration.

The surface water volume and quality in the Little Powder River would be slightly impacted by discharges from Wyoming, resulting in no impacts to downstream users. Irrigators currently tend to use Powder River water for irrigation during high flow events. The SWQATR shows that during the irrigating season (April through October), the SAR increased 33 percent and the EC actually decreased by 33 percent. During the non-irrigation season, the SAR increased by 33 percent and the EC decreased by an average of 49 percent. Wyoming discharges of CBM water would increase surface water flow into the Little Powder River by more than six times, causing major changes to stream conditions including increased flow, channel erosion, and sedimentation during historically low-flow periods.

Mizpah Creek

The Mizpah contains low quality water that has limited irrigation use, but can be used for stock watering and wildlife. This watershed is not expected to be affected by CBM activity under Alternative A, as shown on Table 4-22. This stream water can be compared to the following surface water criteria:

TABLE 4-21
EFFECTS ON SURFACE WATERS OF THE LITTLE POWDER RIVER UNDER ALTERNATIVE A

	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity (Min Mean Monthly) Under Alternative A		
Station	SAR	EC (µS/cm)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)
Little Powder	3	1000	10	3000	3	6.9	3300	16	10.4	1606

TABLE 4-22
EFFECTS ON SURFACE WATER OF MIZPAH CREEK UNDER ALTERNATIVE A

Station	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity (Min Mean Monthly) Under Alternative A		
	SAR	EC (µS/cm)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)
Mizpah Creek at Mizpah	2	1000	10	3200	0.26	16.6	3503	0.26	16.6	3503

- MRPL: Existing stream water is well in excess of these limits for both SAR and EC. The stream could not receive CBM water unless the water was of better quality than the stream, if these limits were adopted.
- LRPL: Except for two months out of the year, average water quality is in excess of SAR limits but within the EC limits for 11 months of the year.
- Ayers and Westcot 1985 water quality plot: Except for 3 months out of the year, the average existing water exceeds irrigation water quality limits set by Ayers and Westcot.

All current uses of these waters would be maintained under Alternative A.

Bighorn and Little Bighorn Rivers

These rivers carry high quality water from the Bighorn Mountains north into Montana. No CBM wells in Wyoming or Montana are expected to impact these rivers under Alternative A. Stream water quality and flow volume are expected to remain unchanged. As shown on Table 4-23, the following expected results can be compared to the following surface water quality criteria:

- MRPL: Existing stream water monthly averages at Wyola except during two months is in excess of these limits for SAR; likewise, the existing stream water is in excess of these EC limits for all but three months of the year. The other two stations are in excess of these limits throughout the year.

  The stream could not receive CBM water unless the water was of better quality than the stream, if these limits were adopted.
- LRPL: The existing stream water monthly averages do not exceed these limits during the year at any of the three stations.
- Ayers and Westcot 1985 water quality plot: The monthly average existing water quality at all three stations is within irrigation water quality limits set by Ayers and Westcot.

All current uses of these waters would be maintained under Alternative A.

Rosebud Creek

This creek drains part of the Powder River Basin in Montana. No CBM water would be discharged into this creek; therefore, stream water quality and flow is unchanged as shown on Table 4-24. These expected results can be compared to the following surface water quality criteria:

- MRPL: Throughout the year, existing stream water monthly averages at both stations are in excess of these limits for SAR and EC. The stream could not receive CBM water unless the water was of better quality than the stream, if these limits are adopted.
- LRPL: The monthly average existing stream water does not exceed these limits at either of the gauging stations.
- Ayers and Westcot 1985 water quality plot: The monthly average existing water quality at both stations is within irrigation water quality limits set by Ayers and Westcot.

TABLE 4-23
EFFECTS ON SURFACE WATERS OF THE LITTLE BIGHORN AND BIGHORN RIVERS UNDER ALTERNATIVE A

	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity (Min Mean Monthly) Under Alternative A		
Station	SAR	EC (µS/cm)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)
Little Bighorn River at Wyola	0.5	500	10	2500	110	0.53	548	110	0.53	548
Little Bighorn at Hardin	0.5	500	10	2500	123	0.99	768	123	0.99	768
Bighorn River at Bighorn	0.5	500	10	2500	1523	2.08	962	1523	2.08	962

All current uses of these waters would be maintained under Alternative A.

Yellowstone River

The Yellowstone River drains all of the Montana watersheds in the Powder River Basin. As such it provides an analysis of the cumulative effects forecasted from CBM development in Montana and Wyoming in the Bighorn, Rosebud, Tongue, and Powder watersheds.

Only the station at Sidney is expected to receive CBM related effects under Alternative A. These effects are in the form of discharge from CX Ranch in Montana and Wyoming CBM wells. After mixing, the flow of the Yellowstone would be increased by 1 percent, the SAR would be increased by 13 percent, and the EC would be increased by 1 percent. The resultant mixed stream water, shown on Table 4-25, can be compared to the following surface water criteria:

- MRPLs: The Yellowstone River is naturally above this SAR limit and could not receive additional CBM discharge if these limits were adopted. The forecasted effects under Alternative A render the stream water farther in excess of these limits.
- LRPLs: These EC and SAR limits would not be exceeded during even the lowest flow periods under Alternative A.
- Ayers and Westcot 1985 water quality plot: The SWQATR's plots predict that the mixed water would not cause infiltration impacts to soils under irrigation under Alternative A.

TABLE 4-24
EFFECTS ON SURFACE WATER OF ROSEBUD CREEK UNDER ALTERNATIVE A

	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity (Min Mean Monthly) Under Alternative A		
Station	SAR	EC (µS/cm)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)
Rosebud Creek at Kirby	0.5	500	10	3000	1.78	0.77	1016	1.78	0.77	1016
Rosebud Creek at Rosebud	0.5	500	10	3000	8.42	4.84	1780	8.42	4.84	1780

TABLE 4-25
EFFECTS ON SURFACE WATER OF THE YELLOWSTONE RIVER UNDER ALTERNATIVE A

Station	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity (Min Mean Monthly) Under Alternative A		
	SAR	EC (µS/cm)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)
Yellowstone at Forsyth, Montana	0.5	500	10	2500	5820	1.99	745	5820	1.99	745
Yellowstone at Sidney, Montana	0.5	500	10	2500	5764	2	870	5805	2.26	881

The surface water volume and quality in the Yellowstone River would not be appreciably affected by discharges from Montana and Wyoming under Alternative A. Discharges of CBM water would only slightly increase surface water flow in the Yellowstone River, causing negligible changes to physical stream conditions, even during historically low-flow periods.

Abandonment

Abandoned well pads would be restored to their original condition with the only effect being the short-term increase in suspended sediments in area surface waters resulting from the increased erosion of disturbed soil. CBM wells that are not produced would be abandoned in accordance with existing regulations and with procedures for the abandonment of oil and gas wells to protect groundwater resources, or converted to monitoring wells as deemed necessary.

Crow Reservation

The Crow Reservation can expect few effects from CBM development within Montana under this alternative. Continued development is expected in the CX Ranch field near Decker. Groundwater drawdown is expected to extend approximately 4-5 miles from the CX Ranch development. This drawdown could impact water wells and springs that receive water from these coal seams on tribal land. Scattered CBM exploration drilling and testing would have only slight effects on reservation coal seam aquifers.

CBM development in Montana and Wyoming could drain groundwater and methane from coal seams under the Reservation.

If Wyoming CBM operators are able to discharge CBM water into either the Little Bighorn or Bighorn watersheds, there could be effects to surface waters on the Reservation. However, there are currently no proposals to develop CBM in these watersheds in Wyoming.

Northern Cheyenne Reservation

The Northern Cheyenne Reservation can expect effects to surface water by CBM development outside the reservation under this alternative. The CX Ranch has a permit to discharge CBM water to the Tongue River and this would continue under this alternative. Effects to surface water are described in detail in the surface water section of this alternative, and in the SWQATR. Groundwater drawdown is expected to extend approximately 4-5 miles from the CX Ranch development. This groundwater drawdown effect would not reach the Northern Cheyenne Reservation.

CBM development in Wyoming is not expected to affect groundwater under the Reservation. Currently, the WYDEQ's policy is to not allow direct discharge of CBM waters into the Tongue River watershed. If the current policy in Wyoming changes and operators are able to discharge water into the Tongue River, the quality of the water in the Tongue River on the reservation would be affected. Meanwhile, accidental releases and unintended infiltration under storage ponds could contribute some effect to the Tongue River from Wyoming.

Conclusion

Montana-based CBM development, conventional oil and gas development, and surface coal mining would have the potential for effects to surface water and coal seam aquifer groundwater resources in Montana. Few CBM wells would be drilled and impacts would be limited in both magnitude and geographic extent. CBM

development at the CX Ranch field could expand, although surface discharge volume to the Tongue River would be controlled by an existing permit. Groundwater impacts to methane-productive coal seam aquifers from the CX Ranch are expected to extend 4-5 miles from the edge of development. Scattered CBM exploration and testing would have a slight effect on static water levels in coal seam aquifers, but would not affect surface waters.

Coal seams that are the targets of surface coal mining operations typically contain groundwater. As a result of the presence of this water, coal mine operators must remove this water as it collects in the bottom of the pits in order to mine the coal. Map 4-2 shows coal mines in the planning area. These mines cover approximately 50,000 acres where coal seam aquifers have been impacted either by the removal, partial depletion, or total depletion of groundwater. In the mining areas around Colstrip and Decker, coal seam aquifers have been drawn down by as much as 75 feet near the coal mines, with a radius of impact of up to 4 miles from the mines (Wheaton and Metesh 2001). The discharge of groundwater pumped from mine pits would also affect surface water depending on the quality of groundwater near the mine and the quantity of groundwater discharged. In instances where the mines do not discharge because all of the recovered groundwater is used, there would be no direct impacts to surface water quality. Much of the groundwater pumped from the mine pits would be stored and used to control dust on roads, truck, and train car loading areas, and the mine face.

Following the release of the Wyodak EIS (BLM 1999b), the RFD for the Wyoming portion of the Powder River Basin was reassessed, and a new RFD was issued (BLM 2001a). This more recent study indicates that the total number of CBM wells in the Wyoming portion of the Powder River Basin may approach 50,000 (BLM 2001a). An EIS using this level of development is in progress for Wyoming,

Groundwater resources in Montana's coal seam aquifers could be affected by CBM production in Wyoming. CBM-producing wells in northern Wyoming would cause a drawdown of coal aquifers on adjacent land, with groundwater drawdown possibly extending northward into Montana.

Given the groundwater modeling results and related assumptions, if CBM fields were located in Wyoming adjacent to the border with Montana, it can be expected that groundwater levels within coal seam aquifers would be drawdown 20 feet at 4-5 miles into Montana. Drawdown impacts of this magnitude would result in impacts on private lands, the Crow Indian Reservation, state-owned lands, and federal lands controlled by BLM. Cumulative groundwater impacts to coal seam aquifers would be largest near CX Ranch and close to the Wyoming border.

Depending on the surface water quality limits adopted by the Montana Board of Environmental Review, cumulative surface water impacts from Wyoming and Montana CBM development under Alternative A could curtail the surface discharge of CBM water in Montana. If Wyoming CBM development reaches expected levels, Montana watersheds could be impacted to the point where water quality criteria (MDEQ 2001c) could prohibit CBM discharge. For this impact analysis, it is assumed that the Wyoming Alternative 2A would be adopted. In addition, it is assumed that the WDEQ Updated Permitting Options for CBM Permit Applications dated 12/10/2001 will remain in effect (Hydrology Appendix). It should also be noted that there are currently agreements in place between the Montana and Wyoming DEQ offices which should protect the Tongue, Powder and Little Powder rivers from having all of their assimilative capacity used by Wyoming's CBM operators.

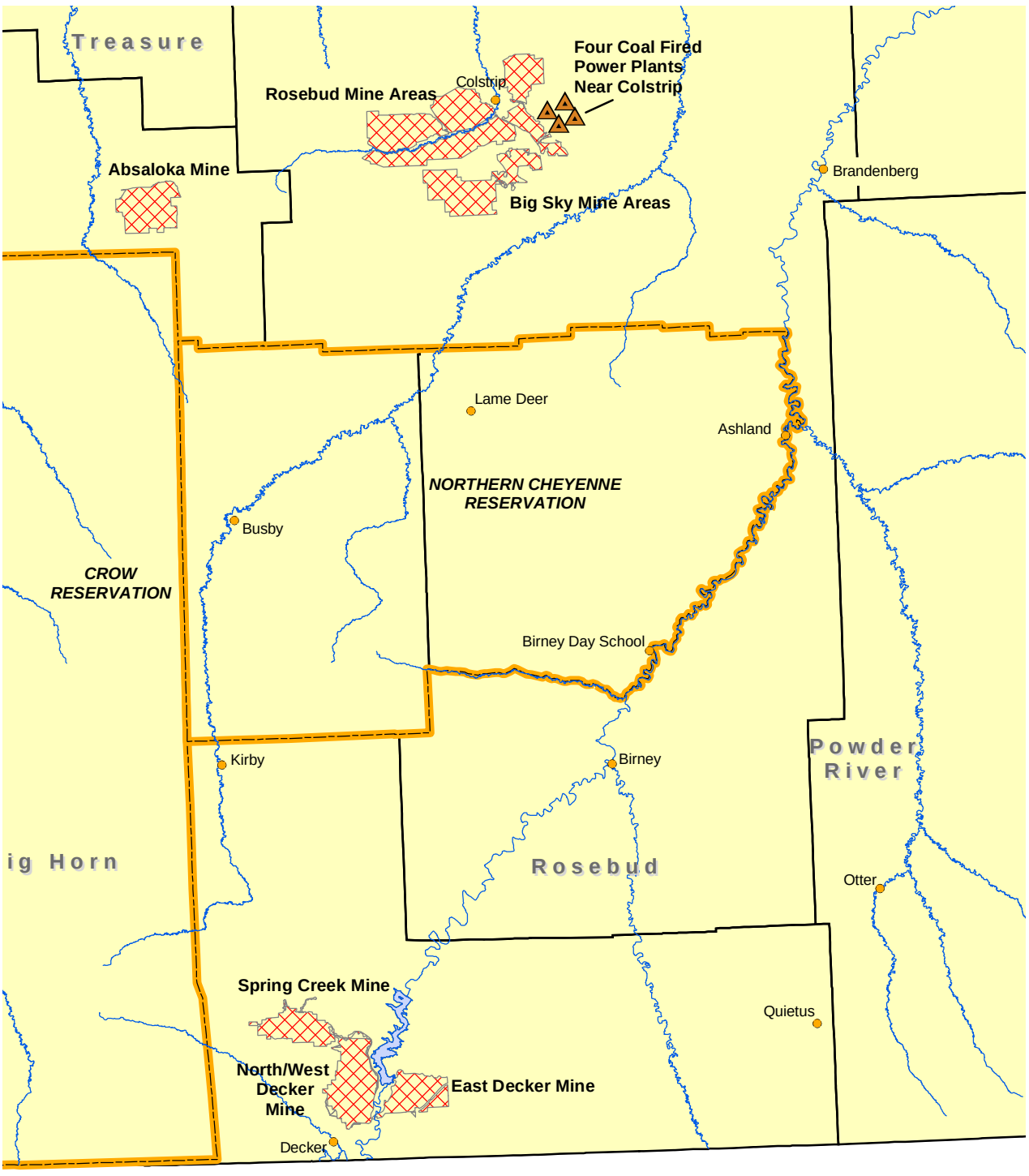
Surface water discharge permits that limit the quantity and quality of discharged CBM water would mitigate the impacts from Wyoming CBM production and from expanded CX Ranch production. Mitigation agreements would be needed to replace water lost from drawdown of groundwater within aquifers and springs impacted by CBM production. If no replacement water is available for mitigation, there may be a need to restrict the volume of water produced.

Beneficial reuse of CBM water is expected to continue in the vicinity of the CX Ranch field as well as other areas near the Wyoming-Montana border. The increased flow of water in some streams may allow increased utilization of the mixed water if quality is appropriate. As there would be little CBM water produced under this alternative, there are no anticipated impacts to the beneficial uses of surface waters.

Alternative B— Emphasize Soil, Water, Air, Vegetation, Wildlife, and Cultural Resources

Alternative B consists of full-scale development of CBM with water produced from CBM exploration wells stored in tanks or impoundments, and all water produced from CBM production wells to be injected into approved subsurface zones other than the coal seam from which it was produced. No CBM water would be discharged to the surface. The number of

Map 4-2: Location Map, Regional Coal Mines



Legend

- Cities
- Rivers
- Coal Mines
- Native American Reservations

5 0 5 Miles

5,000 0 5,000 10,000 Meters

N W E S

DATA SOURCES

County Boundaries: 1:100,000 scale, Counties, Montana State Library/NRIS, Helena, Montana.
Cities: 1:100,000 scale, Cities, Montana State Library/NRIS, Helena, Montana.
Mines: Montana Bureau of Mines & Geology.
Otter Creek Site: EMRIA Report #1, 1975.

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producing CBM wells being analyzed is 16,500, which is the RFD number minus those wells not covered by this EIS (Tribal and USFS wells) minus 10 percent dry holes. The estimated 16,500 CBM wells would draw down groundwater levels within coal seam aquifers in several areas of the state, affecting water wells and springs that draw water from the productive coal seams. The construction of well pads and lease roads would result in surface disturbances that would increase the potential for soil erosion, consequently increasing short-term surface water suspended sediment loads.

Exploration

Full-scale CBM exploration would require water generated from the testing of CBM exploration wells be stored in tanks or impoundments on state and federal lands. Construction permits would require measures to reduce leakage from impoundments. The estimated 2,000 dry CBM exploration wells would result in the short-term disturbance of approximately 2,000 acres of land at the well sites. These disturbed acres would be vulnerable to soil erosion that would cause run-off water impacted by suspended sediment. BMPs to curtail soil erosion such as water bars across lease roads, relieving and mulching cut-banks, and restoration of the surface would serve to mitigate erosion related effects to surface water resources. Short-term testing of CBM exploration wells would not substantially affect static water levels of area coal seam aquifers

Production

CBM production is expected to be concentrated in the Powder River Basin, but could also develop locally in other portions of the state. This full-scale level of CBM development would result in the potential for impacts to surface water resources from increased soil erosion and the accidental releases of produced water. Full-scale development of 16,500 producing CBM wells would disturb an estimated 54,000 acres, which would increase the potential for soil erosion and the corresponding impact to surface water. However, the implementation of BMPs described in the preceding paragraph would reduce the potential for impacts from soil erosion. Because produced water would be disposed by injection into deep aquifers, surface water quality effects are predicted to be the same as Alternative A, and beneficial uses would not be impacted.

The projected 16,500 production wells would generate an estimated average of 2.9 billion cubic feet of produced water per year over 20 years. CBM water produced in Montana is expected to be similar in chemistry to Wyoming CBM water. The produced water would be expected to have a range of SAR values from 22 to 47 and EC values ranging from 2,077 to 3,042 µS/cm.

Using the assumptions in the RFD, and the extrapolated discharge trend line, it is calculated that the maximum annual volume of produced water would occur in year 6 of the plan. During year six, 7,750 wells would be producing with an average rate of 6.2 gpm per well, for a total volume of 3.4 bcf of produced water in that year.

Water management options under this alternative would consist of the injection of CBM-produced waters into approved subsurface zones. No discharge of CBM waters would be allowed. Some of the produced water would be temporarily stored in tanks or impoundments prior to injection. These facilities could fail, causing localized impacts to surface water and shallow groundwater. The implementation of BMPs concerning the location and construction of these impoundments would mitigate the potential for impacts to surface water from the stored produced waters. Berms around tank batteries would reduce the potential for impacts from leaks and catastrophic failures.

Static water levels in produced coal seam aquifers would be drawn down as a result of the pumping required to produce CBM. This drawdown would affect water wells and springs that are completed in or issue from CBM-producing coal seams. The drawdown of Powder River Basin coal seam aquifers as a result of CBM production has been modeled several times. The Montana Bureau of Mines and Geology has performed two studies using Montana field parameters—a two-dimensional model (Wheaton and Metesh 2001) and a three-dimensional model (Wheaton and Metesh 2002). In addition, three-dimensional modeling has been carried out using parameters from the Wyoming portion of the Powder River Basin (BLM 1999a).

The maximum lateral extent of drawdown within coal seam aquifers has been estimated by several methods. Monitoring around dewatered coal mines in the Wyoming portion of the Powder River Basin indicates that 5 feet of drawdown extends from 2 to 14 miles from mined areas after 15 years of mining (US BLM, 1999). 3D groundwater modeling conducted in conjunction with the WYODAK EIS (US BLM, 1999) predicted 5 feet of drawdown at distances from 10 to 22 miles from the edge of production. 2D groundwater modeling, which should represent the maximum limit of drawdown due to vertical leakage being ignored, was conducted in conjunction with this EIS. This 2D modeling indicated that 5 feet of drawdown within the

Powder River Basin may extends up to 11 miles from the edge of CBM production (Wheaton and Metesh, 2001). 3D groundwater modeling of the East Fork of Hanging Woman Creek was also conducted in conjunction with this EIS. This model indicates that the maximum extent of the 5-foot drawdown contour extends up to 7 miles from the edge of production (Wheaton and Metesh, 2002). Based upon this information, the five foot drawdown contour that would likely result from CBM development would extend from 7 to 11 miles from the pumped area. The range of estimates however extends from 2 miles to 22 miles from the pumped area.

These differences between results are not unexpected, and serve as a point to emphasize the site-specific nature of the geology in the Powder River Basin. As the hydrology is fundamentally linked to the geology, it will be critical to manage drawdown related impacts in an adaptive manner, using site-specific data gathered through monitoring. Management alternatives may include re-supply of water to individuals who have springs or wells effected by drawdown (as required by the Powder River Basin controlled groundwater area designation), modification of production plans to limit drawdown impacts to springs where such springs have been determined to be culturally significant, or critical to wildlife, or the installation of a hydrologic barrier (such as injection wells) that will limit the lateral extent of drawdown.

The uncertainty associated with modeling a 5-foot drawdown contour is not insignificant since output of this nature is very sensitive to slight changes in the input parameters used for the model. 5 feet of drawdown would also not, in most cases, impact the usefulness of a well. Since a 20-foot drawdown contour can be modeled with a much higher degree of certainty, and it is a more realistic parameter for evaluation of impacts, the 20-foot drawdown contour is used in this analysis to represent the extent of the drawdown which results from CBM development. Based upon the 3D model prepared in conjunction with this EIS, the 20-foot contour can be expected to extend 4 to 5 miles from the edge of CBM production.

A hydraulic barrier would most likely take the form of a line or system of injection wells. These wells would inject water into the coal aquifer being developed to limit the lateral extent of groundwater drawdown, and prevent that drainage of methane and groundwater resources. It should be emphasized that the installation of a hydraulic barrier is just one of many methods that may be employed to prevent drainage. The feasibility and necessity of installing such a barrier will be addressed on a case-by-case basis. The water injected by a hydraulic barrier system would most likely be obtained from nearby CBM production wells finished in the same aquifer as the injection wells. Class V permits for injection of produced water with less than 3, 000 mg/l TDS would generally need to be obtained from EPA Region VIII for such a project. Other permit requirements may apply depending on the quality of the injected water and quality of the water in the target coal seam.

Coal seam aquifers that do not produce methane may also experience drawdown, but to a much lesser extent because of the confined nature of the individual producing coal seam aquifers (Wheaton and Metesh 2002). Wells and springs that issue from such aquifers would correspondingly be less profoundly affected. Surface aquifers such as stream alluvium and river terraces would show even less effect from CBM withdrawal. The three-dimensional modeling performed for this EIS shows a maximum drawdown in surface aquifers of 6 feet approximately 1 mile outside the CBM field (Wheaton and Metesh 2002).

During the 20-year planning period for CBM production, groundwater levels within coal seam aquifers could be drawn down over large, contiguous areas of the state. For example, the Upper Tongue watershed covers 590,000 acres and could hold 5,800 CBM wells as projected in the RFD. Over the life of the project approximately 5 percent of the groundwater in the coal seam aquifers could be lost to CBM production in this watershed. Following methodology detailed in the *Water Resources Technical Report* (ALL 2001b), potential CBM-producing wells per watershed and potential coal seam aquifer groundwater production estimates for 20 years of production for each of the watersheds have been calculated and are listed in Table 4-26.

The nature of the Fort Union Formation coal seam aquifers that contain the methane gas (i.e., layers of coal interbedded with shale layers having low vertical hydraulic conductivity) should minimize effects to aquifers above and below these seams. Although production of CBM water enhances cleat within the coal seams, it would not propagate vertical fracturing into the adjacent shale confining units.

As more of the groundwater in methane-productive coal seams is depleted, more water wells and springs that deliver water from productive coal seam aquifers would be impacted and it would become more difficult to mitigate water well impacts by transporting water to residents. Depending on the distribution of the CBM development, coal seam aquifer drawdown could be concentrated in scattered producing areas. Mitigation agreements are expected to facilitate replacement of

TABLE 4-26
GROUNDWATER DEPLETION BY CBM DEVELOPMENT IN THE MONTANA POWDER RIVER BASIN

Watershed	Potential CBM Producing Wells	Potential Produced CBM Water in 20 years (billion cubic feet)
Little Big Horn	675	2.5
Little Powder	200	0.7
Lower Bighorn	800	2.8
Lower Tongue	3,450	12.0
Lower Yellowstone	1,700	6.0
Middle Powder	2,100	7.4
Mizpah	125	0.5
Rosebud	3,600	12.6
Upper Tongue	3,850	13.5
Total	**16,500**	**58.0**

Note: Calculated maximum potential coal seam aquifer groundwater production by watershed (billion cubic feet) after 20 years of CBM production. Details on the method used to calculate these numbers can be obtained from the *Water Resources Technical Report* (ALL 2001b).

water lost to the drawdown of groundwater levels within producing coal seam aquifers, but in areas of concentrated depletion water sources may not support water replacement. In such cases, either agriculture that depends upon groundwater, or CBM development would need to be limited.

Recovery of the coal seam aquifers after production ends is a slow process involving recharge from undrained areas of the aquifer, infiltration of precipitation from the surface in areas where the coal aquifers outcrop, and the slow process of infiltration from aquifers above and below the produced coal seams (this is expected to take the longest time because of the confined nature of these units).

Modelers that assisted the Wyoming BLM determined that coal seams that have experienced substantial drawdown also experience recovery as a two-part process:

> "After CBM development (and water removal) ends, within three to four years water levels in the coal aquifers are expected to partially recover to within 20 to 30 feet of pre-operational conditions. Complete water level recovery will be a long-term process, likely requiring hundreds of years for the removed groundwater to be replaced through the infiltration of precipitation." (BLM 2000b).

A similar recovery process is expected to occur in the Montana area of CBM interest with most of the recovery happening in a short time but full coal seam aquifer recovery requiring hundreds of years. The 3D computer modeling conducted in conjunction with the preparation of this EIS estimates recovery schedules for methane-productive coal seams, nonproductive coal seams, and surface aquifers in Montana. For productive coals within CBM fields, the aquifers are expected to recover at least 70 percent of their hydrostatic pressure within 5 to 12 years. Outside the field, productive coals should regain 90 percent of their pressure within 3 to 5 years. Nonproductive coals are predicted to regain 80 percent of their pressure within 5 years. Surface aquifers that are projected to lose only 6 feet of pressure, would regain 50 percent of that pressure in less than 10 years (Wheaton and Metesh 2002). Precise local groundwater recovery differs depending on site-specific conditions.

An estimated 2.9 bcf of produced water would be injected into deep aquifers annually throughout the state. This process would not affect coal seam aquifers. The injection of CBM-produced water has not been conducted in Montana, but is commonplace for waters produced from conventional oil and gas activities. In the year 2000, the state of Montana averaged 847 injection/disposal wells that disposed of 0.6 billion cubic feet of water every year (average injection of 128,000 bbl of water per well per year). Injection of

CBM water under this alternative is estimated to increase the number of injection wells to nearly 3,000. These new CBM injection wells would have an average injection rate of 265,000 barrels of water per well per year. This water would be injected into deep aquifers, whose water is not fit for use. Given the effectiveness of current injection regulations, the increase in injected volume resulting from CBM production is anticipated to have only a minimal effect on surface water or groundwater resources.

In those portions of Montana where CBM is developed outside of the Powder River Basin, CBM production is not expected to be as concentrated and hydrological impacts would be less. Limited CBM production in these areas would result in the localized drawdown of groundwater levels within coal seam aquifers. The extent of a 20 foot drawdown is estimated at less than 5 miles from the edge of production (Wheaton and Metesh 2001).

Abandonment

When the estimated 16,500 production wells are abandoned throughout the life of the resource in the planning area, 33,000 acres of soil would be disturbed for a short time period. This disturbed soil would be vulnerable to erosion and the resulting suspended material could be washed into adjacent surface waters unless mitigating measures are employed. The implementation of BMPs would mitigate the potential for impacts to surface water resources resulting from soil erosion until groundcover and original site conditions are restored. CBM wells that are not produced, or have reached the end of their productive life would be abandoned in accordance with existing regulations, and procedures for the abandonment of oil and gas wells to protect groundwater resources, or converted to monitoring wells, as deemed necessary.

Crow Reservation

Surface water effects on Crow Tribal Lands under Alternative B would include those impacts noted in Alternative A. Additional impacts from suspended sediment due to soil erosion and runoff from the disturbed acreage are expected near the Crow Reservation from the development of fee land within the exterior boundaries of the Crow Reservation, or from development of CBM on Tribal Lands.

Groundwater impacts would include those detailed in Alternative A as well as additional impacts from nearby wells. The Tribe can expect up to 20 feet of drawdown in coal seam aquifers from CBM wells within 4 to 5 miles of the Reservation boundaries towards the later part of the 20 year production period. The drawdown in producing coal seams may be as high as 10 feet for wells within 1 to 2 miles of the boundary during the early stages of production. This drawdown would affect water wells and springs within the reservation that derive water from productive coal seam aquifers.

In addition, because of the large presence of fee land within the exterior boundaries of the Crow Reservation, CBM development on those non-reservation lands could also affect surface water and groundwater in a manner consistent with other areas of the Powder River Basin. The development of CBM on fee lands within the reservation boundary could result in increased suspended sediment loads from surface disturbances in the Bighorn, Little Bighorn, Rosebud, and Squirrel Creek watersheds.

Northern Cheyenne

Surface water effects on Northern Cheyenne Tribal Lands under Alternative B would include those impacts noted in Alternative A. Additional effects are expected from suspended sediment as a result of soil erosion and runoff from the area upstream of the Northern Cheyenne Reservation. Increased sediment loads would affect both the Tongue River and Rosebud Creek watersheds resulting from the surface disturbances associated with CBM development. Groundwater drawdown effects on the reservation would be similar to impacts in other areas of the Powder River Basin. The Tribe can expect up to 20 feet of drawdown in the produced coal seam aquifers from wells 4 to 5 miles from the reservation boundary. This drawdown would affect water wells and springs within the reservation that derive water from the produced coal seam aquifers.

Conclusion

Impacts on surface water and groundwater as a result of Wyoming CBM development would be same as discussed under Alternative A. Impacts on surface water would include those impacts listed under Alternative A plus the impact of suspended sediment generated by soil erosion taking place near CBM development. There would be no substantial increase in surface water flow beyond what was described for Alternative A because all CBM produced water would be managed by deep injection.

CBM production in Montana under Alternative B would result in the withdrawal of approximately 5 percent of the groundwater resources contained within the producing coal seams and approximately 0.1 percent to 0.2 percent of the total recoverable groundwater resources that underlie Montana's portion

of the Powder River Basin. This withdrawal estimate was derived from Specific Storage values ($3x10^{-4}$ to 9 x 10^{-4}) from modeling (Wheaton and Metesh, 2002) assuming an average of 70 feet of coal and a drawdown of 200 feet needed to release economic volumes of methane. Water wells near CBM fields could experience drops in static water levels in excess of 100 feet. Water well and spring mitigation agreements would facilitate replacement of groundwater lost to the drawdown of groundwater levels within these coal seam aquifers. Replacement of groundwater supplies may be difficult in some areas and may require supply from off-site sources.

Alternative C—Emphasize CBM Development

Alternative C consists of the direct discharge of CBM-produced waters to the land surface. Impacts to water resources resulting from this alternative would consist of coal seam drawdown-related effects similar to Alternative B, and effects due to the large volume of CBM water being discharged to the ground and allowed to flow into drainages and water bodies.

Discharge to the ground would cause increased soil erosion between the discharge point and the nearest drainage. There would be a corresponding increase in the suspended sediment load in surface waters adjacent to CBM development. As CBM water flows along drainages, infiltration of the water would occur, resulting in rising shallow groundwater elevations, and shifts in the chemistry of the shallow groundwater. These shifts in groundwater chemistry may improve or degrade the usability of the groundwater, depending on site-specific conditions. In the long term, this infiltration would result in diffuse discharge of CBM water into waterways as the CBM water flows downgradient in the alluvial aquifers until a perennial waterway is reached.

CBM water that does not infiltrate or evaporate en route would reach perennial waterways as point discharges. The addition of CBM water to drainages and surface water bodies, through both point and diffuse discharges, would result in increased flow volumes and changes in water chemistry. These changes would, in turn, lead to loss of soil structure, increased erosion rates, and increased suspended sediment loads. The chemistry of the surface waters would also potentially impact some uses by humans and wildlife.

Exploration

Impacts would be similar to those described in the Alternative B discussion. The moderate volume of water generated by the testing of CBM exploration wells would be stored in tanks or impoundments to be discharged under the appropriate permits.

Production

Alternative C assumes that 80 percent of the volume of CBM water produced would be discharged directly to the land surface adjacent to the wellhead. Impacts to water resources would consist of those effects of coal seam drawdown described in Alternative B, soil erosion and the increase in suspended sediments in area rivers and streams, changes in the elevation of groundwater in alluvial aquifers, changes in alluvial aquifer water chemistry, and changes in the chemistry of perennial water bodies. The discharge at the CBM wellhead would result in the erosion of soils, creating gullies that would connect to natural runoff areas where the water would join natural drainage. These natural drainages or ephemeral portions of the water-course would also be impacted by increased erosion and would likely become more nearly perennial as a result of receiving CBM discharge water. Before the CBM water reaches surface water, some portion would evaporate or infiltrate into the soil. The portion lost would depend upon season of the year, permeability of the soil, and the presence of a shallow, unconfined aquifer connected to surface water.

Produced water discharged to the surface would be released by one of the following routes: directly to surface water or drainages, into on-drainage impoundments, and into off-drainage impoundments. These three discharge routes would impact surface and groundwater in different ways:

- Water lost to infiltration or evaporation would depend upon the distance of transport to the surface water body, the amount of CBM water discharged, the physical characteristics of the drainage, and climatic conditions.

- Discharge to an impoundment constructed by damming an ephemeral drainage (on-drainage pond) would result in losses by evaporation and infiltration. The infiltration would lead to groundwater doming under the pond that could rise far enough to intersect the ephemeral stream, causing discharge to the stream during part or all of the year. Drainage impoundments would also prevent stormwater runoff from flowing down drainage and into perennial surface water bodies.

- Discharge to an impoundment constructed near the ridge-line separating drainages (off-drainage pond) would also result in losses by evaporation and infiltration, but the infiltration and groundwater doming associated with infiltration would have less tendency to intersect ephemeral drainages.

Saline seeps may form below both off-drainage and on-drainage discharge reservoirs as salt-laden waters seep out intersect a confining layer, and flow to the outcrop. All surficial discharges must comply with an MPDES permit. A copy of the Montana general discharge permit for coal bed methane produced water is attached at the end of the Hydrology Appendix. The MPDES fact sheet can be obtained from the MDEQ.

Losses associated with evaporation would reduce water volume, but not reduce salt load, and would increase the salinity of the water remaining in the impoundment. How much evaporation takes place would depend upon residence time in the pond and climatic conditions of humidity, temperature, wind, and rainfall. Increased salinity in the stored water would act upon the pond's soil liner by causing dispersal of the clay particles in the soil. Increased salinity would tend to reduce the pond's permeability, reduce subsequent infiltration, and increase residence time in the pond.

It is likely that water that infiltrates into shallow, unconfined alluvial aquifers would be delayed in reaching surface water but not be completely lost to the system. A Portion of the projected conveyance loss would enter shallow groundwater flow systems and eventually reach streams and rivers.

Surface waters could be impacted by infiltrated water that contacts shallow groundwater sources and eventually discharges into surface water bodies. Infiltrated water that was stored in an impoundment would have elevated concentrations of some constituents as a result of evaporation. As this water infiltrates through the soil and bedrock, changes to its quality would occur from interactions with the soil, rock, and connate water. The impacts from this water would be difficult to quantify as the distance and residence time within shallow aquitards and shallow aquifers affect the quality of the water that might subsequently be discharged into the surface waters.

Produced water would also be placed into impoundments for use by livestock and wildlife. Water placed in impoundments can be lost to evaporation and seepage/infiltration into the soil below the impoundment. Impoundments are usually constructed of native soil present on site, however, local soils vary widely in their permeabilities as described in the *Soils Technical Report* (ALL 2001a). Impoundments constructed of sandy soils would allow more infiltration of produced water than those built from clay. Water stored in sandy impoundments would be more liable to seep into deeper soil horizons where the water could increase the salinity of the soils. Produced water would also be able to seep into unconfined aquifers if these were present, modifying the quality of the native groundwater. The specific soil types and impoundment locations are unknown with regards to future CBM developments in Montana. The degree of produced water infiltration cannot be estimated without site-specific data. A copy of the Montana general discharge permit for coal bed methane produced water that is discharged to holding pounds is attached at the end of the Hydrology Appendix. The MPDES fact sheet of this general permit can be obtained from the MDEQ.

Impacts on groundwater under this alternative would be the same as in Alternative B, except that discharged water could infiltrate into soils and underlying shallow alluvial aquifers. The produced water from the only Montana CBM field (CX Ranch) has an SAR value in excess of the water contained in most shallow aquifers, including the alluvial aquifers (ALL 2001b). If infiltration of CBM-produced water occurred, the water quality of the alluvium could be adversely impacted.

Surface Water Analysis

Surface waters that could be affected by developments connected with this alternative include the watersheds connected with the Tongue, Powder, Little Powder, Little Bighorn, Bighorn, and Yellowstone Rivers. In addition, other watersheds in nearby counties, including the counties of Gallatin, Stillwater, and Blaine, may be affected by statewide development of CBM resources. The following discussion concentrates on watersheds of the Powder River Basin, because the Powder River Basin is the most likely area for major CBM activity that could impact surface water resources. Reference is made to the water quality limits proposed by various interest groups within the Powder River Basin, including the MDEQ, the Northern Cheyenne Tribe, and other Petitioners. With the exception of the Northern Cheyenne Tribe's standards that have been approved by the Tribe and are awaiting the EPA's approval, these standards are proposed ranges, which may or may not be the limits that are accepted by the State of Montana. Modeling results are also compared to scientifically accepted criteria, particularly the Ayers and Westcott (1985) EC versus

TABLE 4-27
EFFECTS ON SURFACE WATERS OF THE TONGUE RIVER UNDER ALTERNATIVE C

Station	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity (Min Mean Monthly) Under Alternative C		
	SAR	EC (µS/cm)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)
Tongue River at Stateline near Decker	0.5	500	10	2500	178	0.86	731	187	2.68-2.94	806-812
Tongue River Near Birney Day School	0.5	500	10	2500	183	1.09	863	213	6.38-7.43	1055-1080
Tongue River at Brandenburg Bridge near Ashland, Montana	0.5	500	10	2500	207	1.36	1016	265	9.51-11.22	1278-1319

SAR relationship of impacts to the infiltration capacity of irrigated soils.

Tongue River

The Tongue River could be impacted from current and future CBM development in both the Wyoming and Montana portions of the Powder River Basin. The detailed input data, calculation of effects, and a summary of impacts are presented in the SWQATR.

Table 4-27 encapsulates the effects for three stream stations along the Tongue River in Montana for Alternative C.

These results show the combined effects for CBM water discharged from RFD development for Wyoming and Montana. These discharges would result in a 10 to 27 percent increase in surface water EC, a 211 to 725 percent increase in surface water SAR, and a 5 to 28 percent increase in flow. The resultant mixed stream water can be compared to the following surface water criteria:

- MRPLs: These limits are set at 0.5 SAR and 500 µS/cm EC for the Tongue River. As such, the Tongue River's existing stream water quality is above these SAR and EC limits, and it would not be able to receive additional CBM discharge if these limits were adopted. The forecasted impacts from Wyoming and Montana CBM water under Alternative C, are even further in excess of these limits.

- LRPLs: These limits are set at 10 SAR and 3000 µS/cm EC for the Tongue River. The resultant mixed water quality during Minimum Mean Monthly flow would only exceed these limits at the Ashland station under Alternative C. All other monthly average mixed waters would be below these limits; the 7Q10 flow would be in excess of the SAR limit.

- Northern Cheyenne Proposed Standards: The resultant mixed water quality at the stateline station would exceed the proposed irrigation season limits for SAR during 5 months out of the year and the 7Q10; the 7Q10 flow would also exceed the EC limit. The resultant water quality is similarly above the non-irrigation season proposed limits.

  The resultant water quality at the Birney Day School station, near the southern boundary of the Reservation, would exceed the SAR limit for 11 months of the year and would only exceed the EC limit during 7Q10 flows. The water quality near the northern end of the Reservation is seen at the Ashland station. The calculated impacts at Ashland demonstrate that the Northern Cheyenne proposed standards would be exceeded for SAR on all but one month while the EC limits would not be exceeded.

- Ayers and Westcot (1985) water quality plot: Impact analyses show that Tongue River water at Decker would not result in impacts to soil except during 7Q10 flow. The resultant water quality at the Birney Day School and Ashland stations would result in some impacts to soil during irrigation use. Texture and permeability, especially of clayey soils, could be reduced if the mixed Tongue River water from Birney Day

TABLE 4-28
EFFECTS ON SURFACE WATERS IN THE POWDER RIVER UNDER ALTERNATIVE C

Station	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity (Min Mean Monthly) Under Alternative C		
	SAR	EC (µS/cm)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)
Powder River at Moorhead	2	1000	10	3200	145	4.65	2154	231	11.08-11.56	2226-2253
Powder River at Locate	2	1000	10	3200	143	4.61	2287	250	11.97-13.13	2323-2361

School and Ashland were to be used for irrigation. Irrigators would need to alter their management schemes to avoid these impacts under Alternative C. Plots showing these effects are included in the SWQATR.

The surface water quality of the Tongue River would be reduced, requiring management practice changes by downstream users during part or all of the year under Alternative C. Although this is a legal option, so long as a CBM producer were granted a permit to degrade surface waters by the MDEQ, such an action would be contrary to the current policy of MDEQ, and the US EPA.

Powder River

The Powder River has its headwaters in the Wyoming portion of the Powder River Basin and as such would receive CBM water from development in Wyoming and Montana. The detailed analysis and calculations for the data summarized in Table 4-28 can be found in the SWQATR. Table 4-28 summarizes the impacts for two stations along the Powder River for Alternative C during the minimum mean monthly flow. The analysis conducted at the Locate station includes all CBM discharge in the Powder, Little Powder, and Mizpah watersheds, cumulatively.

The Powder River contains water that is naturally above some of the proposed limits. The Powder River is expected to be affected by Wyoming and Montana CBM development under this alternative. The resultant water quality is altered by slight changes of 1 percent to 3 percent for EC, but SAR increases by as much as 200 percent. The flow rate is expected to increase between 25 percent and 30 percent. The resultant mixed stream water and CBM water can be compared to the following surface water criteria:

- MRPLs: These limits are set at 2.0 SAR and 1000 µS/cm EC for the Powder River. As such, the Powder River's existing stream water quality is above the SAR and EC limit and it would not be able to receive additional CBM discharge if these limits were adopted. The forecasted effects from Wyoming and Montana CBM water are even further in excess of these limits.
- LRPLs: These limits are set at 10 SAR and 3,200 µS/cm EC. The resultant mixed water quality during Minimum Mean Monthly flows and 7Q10 flows would exceed the SAR limit at the Locate station. All other Locate station mixed waters would be below these limits. The Moorhead station's mixed water quality would exceed the proposed SAR limit for half of the months analyzed, and for the 7Q10 flow. The proposed EC limits would only be exceeded at the Moorhead station during 7Q10 flow.
- Ayers and Westcot (1985) water quality plot: The SWQATR displays the SAR vs EC plots that show that the only time the water quality at the Powder River stations would be likely to cause infiltration impacts to soils under irrigation is during 7Q10 flow.

The surface water quality in the Powder River is reduced under Alternative C. These effects would likely require management practice changes by downstream irrigators. Although this is a legal option, so long as a CBM producer were granted a permit to degrade surface waters by the MDEQ, such an action would be contrary to the current policy of MDEQ, and the US EPA.

TABLE 4-29
EFFECTS ON SURFACE WATERS IN THE MIZPAH CREEK UNDER ALTERNATIVE C

Station	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality (Min Mean Monthly) Under Alternative C		
	SAR	EC (µS/cm)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)
Mizpah Creek at Mizpah	2	1000	10	3200	0.26	16.6	3503	0.99	20.43-35.26	2663-3163

Little Powder River

The effects to the Little Powder River station at Weston, Wyoming, would be the same as Alternative A since there are no Montana wells being discharged upstream of this station. The impacts from Montana wells downstream of this station are analyzed in the analysis for the Powder River at Locate station.

Mizpah Creek

Mizpah Creek carries water into the Powder River in Montana. There are no CBM wells in Wyoming that could effect this watershed. Under Alternative C effects to Mizpah Creek would result from the discharge of Montana CBM produced water only. Table 4-29 summarizes predicted changes in surface water chemistry in Mizpah Creek just upstream from its junction with the Powder River.

Mizpah Creek contains water that naturally exceeds the LRPLs. Although CBM discharge would decrease surface water EC by 10 to 24 percent, the SAR would increase by 25 to 112 percent. The resultant mixed stream water can be compared to the available surface water criteria:

- MRPLs: These limits are set at 2.0 SAR and 1,000 µS/cm EC and, as such, Mizpah Creek's existing stream water quality is well above the SAR and EC limits. The mixed water EC would decrease but SAR would increase. This would cause these waters to further exceed the SAR standard and so no discharge could occur in this creek if these standards were adopted.
- LRPLs: These limits are set at 10 SAR and 3,200 µS/cm EC. As such, Mizpah Creek's existing stream water quality is above the SAR and EC limits. The mixed water EC would decrease but SAR would increase. This would cause these waters to further exceed the SAR standard and so no discharge could occur in this creek if these standards were adopted.
- Ayers and Westcot (1985) water quality plot: The SWQATR displays the plots that show the mixed water quality at the Mizpah station would likely cause infiltration impacts to soils under irrigation during all flows except for one or two high flow months a year. Discharge of CBM waters would cause further exceedance of these criteria.

The surface water quality of Mizpah Creek would be reduced under Alternative C, however, as these waters are currently in excess of all criteria considered, this would not result in an impact to beneficial use.

Bighorn and Little Bighorn Rivers

These rivers carry water from the Bighorn Mountains north from Wyoming into Montana. No CBM wells in Wyoming are expected to affect these rivers. Under Alternative C, the effects to these Rivers would be the result of discharge from Montana CBM discharge only. Table 4-30 summarizes the effects for two stations along the Little Bighorn River and one on the Bighorn River, just upstream from its confluence with the Yellowstone River, for the minimum mean monthly flow.

The resultant water quality impacts for these rivers would include an increase in EC by approximately 11 percent to 162 percent and an SAR increase of 27 percent to 400 percent. Flows would increase by 2 to 8 percent. The resultant mixed stream water can be compared to the following surface water criteria:

- MRPLs: These limits are set at 0.5 SAR and 500 µS/cm EC. The existing stream water quality in these rivers is above the SAR and EC limits during several months at several stations and would not be able to receive additional CBM discharge if these limits were adopted. The forecasted effects from Montana CBM

TABLE 4-30
EFFECTS ON SURFACE WATERS OF THE BIGHORN AND LITTLE BIGHORN RIVERS UNDER ALTERNATIVE C

	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity (Min Mean Monthly) Under Alternative C		
Station	SAR	EC (µS/cm)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)
Little Bighorn River at Wyola	0.5	500	10	2500	110	0.53	548	115	2.26-2.64	623-632
Little Bighorn River at Hardin	0.5	500	10	2500	123	0.99	768	133	3.94-4.59	881-896
Bighorn River at Bighorn	0.5	500	10	2500	1523	2.08	952	1542	2.54-2.64	968-970

development under Alternative C are even further in excess of these limits.

- LRPLs: These limits are set at 10 SAR and 2,500 µS/cm EC. As such, the Hardin station's existing stream water quality during 7Q10 is above the SAR limit. For the rest of the stations and flows, the mixed water quality parameters would be well below these limits.
- Ayers and Westcot (1985) water quality plot: The Technical Report displays the plots that show the mixed water quality at the Wyola and Hardin stations would be likely to cause infiltration impacts to soils under irrigation during several months of the year. The resultant water qualities represent a low EC to SAR relationship and thus the water would likely impact clayey soils if used for irrigation. Water quality at Bighorn would likely cause no infiltration impacts and be adequate to use for irrigation.

The surface water quality in the Bighorn Rivers in Montana is slightly reduced, resulting in minor management practice changes by downstream users for continued irrigation use. Although this is a legal option, so long as a CBM producer were granted a permit to degrade surface waters by the MDEQ, such an action would be contrary to the current policy of MDEQ, and the US EPA.

Rosebud Creek

Rosebud Creek drains part of the area of the Powder River Basin in Montana. This creek begins on the Crow Reservation, flows through a portion of Montana, flows through the Northern Cheyenne Reservation, then through another portion of Montana prior to joining the Yellowstone River near Rosebud Montana. No CBM wells in Wyoming could affect the Rosebud. The effects to this stream would be the result of CBM discharges in Montana. Table 4-31 summarizes the predicted effects for two stations along Rosebud Creek in Montana for the minimum mean monthly flow.

These results show the effects of CBM discharge on the flow and water quality of Rosebud Creek. Because there is so little water in the Creek naturally, flow increases by an order of magnitude with CBM discharge and water quality is more representative of the CBM discharged water than the existing stream water quality. The resultant mixed stream water and CBM water can be compared to the available surface water criteria:

- MRPLs: These limits are set at 1.0 SAR and 500 µS/cm EC. As such, Rosebud Creek's existing stream water quality is above the SAR and EC limit and would not be able to receive additional CBM discharge if these limits were adopted. The forecasted effects from Montana CBM water under Alternative C are far in excess of the MRPL.
- LRPLs: These limits are set at 10 SAR and 2,500 µS/cm EC. Both the stations' mixed stream water qualities are well above the SAR limit but below the EC limit.

TABLE 4-31
EFFECTS ON SURFACE WATER OF ROSEBUD CREEK UNDER ALTERNATIVE C

Station	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity (Min Mean Monthly) Under Alternative C		
	SAR	EC (µS/cm)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)
Rosebud Creek at Kirby	1.0	500	10	2500	1.78	0.77	1016	22	35.62-43.25	2110-2293
Rosebud Creek at Rosebud	1.0	500	10	2500	8.42	4.84	1780	49	32.85-39.32	2133-2298

- Ayers and Westcot (1985) water quality plot: The plots show that the mixed water quality at the Kirby and Rosebud stations would likely cause severe infiltration impacts to soils under irrigation during all months of the year under Alternative C.

Under Alternative C, the surface water quality in Rosebud Creek in Montana is reduced, resulting in severe curtailment of irrigation use of this water. Although this is a legal option, so long as a CBM producer were granted a permit to degrade surface waters by the MDEQ, such an action would be contrary to the current policy of MDEQ, and the US EPA.

Lower Yellowstone River

The waters of the Yellowstone River are the confluence of all the other watersheds that are expected to receive effects from CBM development in Montana. The Forsyth station would be affected by CBM discharges into the Bighorn and Little Bighorn watersheds. The Sidney station would be affected by all Montana CBM development, and that development in Wyoming that occurs in the Tongue, Powder, and Little Powder watersheds. Table 4-32 summarizes the impacts for two stations along the Yellowstone River in Montana for the minimum mean monthly flow for Alternative C.

Because of the significant volume of water available in the Yellowstone to dilute the CBM production water in Montana and Wyoming, the resultant water quality shows only slight changes in both EC and SAR. The resultant mixed stream water and CBM water can be compared to the following surface water criteria:

- MRPLs: These limits are set at 0.5 SAR and 500 µS/cm EC. The Yellowstone River's existing stream water quality is above the SAR and EC limit for all months out of the year and would not be able to receive additional CBM discharge during these times if these limits were adopted. The forecasted impacts from Wyoming and Montana CBM water under Alternative C are also exceeded by these limits.

- LRPLs: These limits are set at 10 SAR and 2,500 µS/cm EC. As such, the mixed stream water qualities are well below these limits.

- Ayers and Westcot (1985) water quality plot: The plots show that the mixed water quality would not cause infiltration impacts to soils under irrigation at any time. Under Alternative C, the surface water quality in the Yellowstone River in Montana is slightly reduced; however, there should be no management practice changes required of downstream users for continued irrigation use of this water. The resultant water quality in the Yellowstone River is sufficient for irrigation even during the months with the lowest flows.

Abandonment

Effects on water resources caused by abandonment operations would be similar to impacts by produced water discharged to the surface. The two activities—soil disturbance at abandonment and 20 years of surface discharge—would combine to increase the suspended sediment load within area surface water streams and rivers.

Crow Reservation

Effects on the Crow Reservations' surface water would be in the form of increased flow volume and changes in water quality. Groundwater impacts would be the same as Alternative B. In addition, potential CBM development on fee land within the external

TABLE 4-32
EFFECTS ON SURFACE WATERS OF THE YELLOWSTONE RIVER UNDER ALTERNATIVE C

Station	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity (Min Mean Monthly) Under Alternative C		
	SAR	EC (µS/cm)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)
Lower Yellowstone-Sunday near Forsyth	0.5	500	10	2500	5820	1.99	745	5850	2.18-2.22	753-754
Lower Yellowstone-Sunday near Sidney	0.5	500	10	2500	5764	2.00	870	5945	3.12-3.31	912-917

boundaries of the reservation could cause more direct effects that would also be similar to those effects described for the CBM emphasis area. Surface waters would be affected in terms of both quantity and quality based on the extent of discharge to the watersheds within the reservations boundary (Bighorn, Little Bighorn, Rosebud, and Squirrel Creek watersheds). The effects on these surface waters would place additional impacts onto the Tribe's way of life by limiting the uses of effected waters.

Northern Cheyenne

Effects on the Northern Cheyenne Reservation are similar to effects projected for the CBM emphasis area. Effects to surface water would include increases in flow volume and changes in various water quality parameters in the Tongue River and Rosebud Creek watersheds. The effects to the Tongue River and Rosebud Creek watersheds from Wyoming and Montana CBM development could affect existing uses of these waters within the reservation boundary. Groundwater effects would be the similar to Alternative B, with additional impacts resulting from the infiltration of produced water into shallow aquifers along the Tongue River and Rosebud Creek watersheds within the reservation boundary.

The effects to these surface waters would limit the uses of affected waters. The changes to groundwater quality that result from infiltration would be site-specific and depend on the quality of the alluvial aquifers. The Tribe can expect drawdown of coal seam aquifers from CBM production in the area surrounding the reservation for distances of approximately 4 to 5 miles.

Conclusion

Effects on groundwater include those listed under Alternative B, as well as effects from infiltration of surface water into shallow aquifers from impoundments and drainages.

Surface water quality in some watersheds would be slightly to severely degraded, resulting in restricted downstream use of some waters. Surface water flows will be considerably increased in some watersheds, causing persistent riparian erosion, changes in watercourses, and increased sedimentation. The LRPLs would be exceeded in the Tongue and Powder River and Mizpah and Rosebud Creek watersheds under the minimum monthly flows. However, there are other months where discharges would be allowed in all of these watersheds where the resultant water quality would not exceed the LRPL or other relevant limits.

The Bighorn, Little Bighorn, and Lower Yellowstone rivers' resultant water quality would be below the LRPLs, even during the minimum monthly flows.

Area surface waters would be affected by an increase in suspended sediments contained in the discharged CBM water. This increase in suspended sediment load would result from the increased erosion of soils due to surficial disturbances, CBM water runoff from the point of discharge to drainages, and from the increased erosion of stream banks resulting from increased water volume and increased SAR (which causes clays to lose their cohesiveness and erode more easily). The increase in suspended sediment content of surface water could affect its beneficial uses. All of the watersheds in the CBM emphasis area would be vulnerable to effects from an increase in suspended sediment. Discharge to ephemeral channels would cause deepening and widening of the channels.

TABLE 4-33
SUMMARY OF SURFACE WATER PARAMETERS BEFORE AND AFTER MIXING[1]
UNTREATED CBM DISCHARGE FROM WYOMING AND TREATED CBM DISCHARGES FROM MONTANA UNDER ALTERNATIVE D

	Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity Under Alternative D (Min Mean Monthly)		
Station	**Flow (cfs)**	**SAR**	**EC (µS/cm)**	**Flow (cfs)**	**SAR**	**EC (µS/cm)**
Tongue River Stateline Near Decker	178	0.86	731	187	1.49	747
Tongue River Near Birney Day School	183	1.09	863	213	1.59	824
Tongue River at Brandenburg Bridge Near Ashland, Montana	207	1.36	1016	265	1.67	904
Little Bighorn River at Wyola	110	0.53	548	115	0.53	548
Little Bighorn River at Hardin	123	0.99	768	133	0.99	768
Bighorn River at Bighorn	1523	2.08	952	1542	2.08	952
Rosebud Creek at Kirby	1.78	0.77	1016	22	0.77	1016
Rosebud Creek at Rosebud	8.42	4.84	1780	48	4.84	17804
Little Powder River Stateline Station Weston, WY (No Montana CBM wells will impact this station)	2.6	6.94	3300	16	10.41	1606
Powder River at Moorhead	145	4.65	2154	231	11.08	2226
Powder River at Locate	143	4.61	2287	250	10.89	2268
Mizpah Creek at Mizpah	0.26	16.6	3503	1.26	16.6	3503
Yellowstone at Forsyth, Montana	5820	1.99	745	5831	1.99	745
Yellowstone at Sidney, Montana	5764	2	870	5805	2.23	8703

[1] Calculations of flow volume and water quality were conducted for low mean monthly stream flows, and the maximum calculated levels of CBM discharge (year 6 discharge).

Alternative D— Encourage Exploration and Development While Maintaining Existing Land Uses

An estimated 20 percent of produced water would be used for beneficial uses, and the remaining 80 percent would be treated to pre-development surface water chemistry prior to discharge under a MPDES permit.

Discharge would be accomplished by pipeline or constructed watercourse to the nearest body of water to eliminate soil erosion, the generation of suspended sediments, and the infiltration of treated CBM water. The treatment of CBM-produced waters would eliminate or greatly reduce effects to surface waters. Treatment may increase the potential for beneficial uses of CBM water.

The changes in surface water quality shown in Table 4-33 for Alternative D are due to the discharge of untreated CBM water from Wyoming CBM development. Changes in flow volume are due to treated and untreated discharges in both Montana and Wyoming. The effects originating from Wyoming would be the same as those detailed under Alternative A. Effects on surface water from Montana CBM development are due to the increases in baseflow. The stations analyzed would experience a 0.2 percent (Yellowstone at Forsyth) to 1135 percent (Rosebud at Kirby) increase in flow under this alternative. These increases in water flow rates would be likely to cause changes in streambed geometry, flow regime, stream depth distribution, presence and condition of instream vegetation, and other physical factors associated with the stream and adjacent riparian zone.

Exploration

Any water generated by drilling and testing would be treated, with 80 percent of the treated water discharged via pipeline under a MPDES permit and 20 percent used for beneficial purposes. Treatment would eliminate potential impacts to water quality. Water quantity impacts would be minor because of the moderate volume produced from the testing of CBM exploration wells.

Production

Approximately 80 percent of CBM-produced water would be treated and discharged under this alternative. Because the water is piped to the receiving body of water, no conveyance losses are deducted.

Peak total field discharge during year 6 would add about 0.7 percent to the total water discharged to the Yellowstone. In detail, every watershed, except the Yellowstone, and the Bighorn, experience at least a 10 percent increase in flow in at least one portion of the watershed. Rosebud Creek, the Little Powder, and Mizpah Creek would experience the greatest percentage change in baseflow during year 6, with 1,135 percent, 515 percent, and 285 percent increases in baseflow respectively. These increases in flow volume would result in increased erosion in affected watersheds. Since discharge water would be treated, the water quality of the streams, and therefore the beneficial uses of surface waters, would not be effected

The treatment of CBM-produced waters could result in the generation of residues that would contain concentrated salts extracted from the CBM water. This residum would need to be analyzed on a case-by-case basis to determine its character and would need to be disposed of in an appropriate manner.

Effects on groundwater from CBM production under Alternative D would be similar to those described for Alternative B.

Abandonment

Effects on water resources caused by abandonment operations would be similar to the effects identified under Alternative B. When the estimated 16,500 CBM production wells are abandoned over the 20-year life of the resource, 33,000 acres of soil would be disturbed for a short time period. This disturbed soil would be vulnerable to erosion and the resulting suspended material would be washed into adjacent surface waters unless mitigating measures are employed. The implementation of BMPs would control soil erosion until groundcover and original site conditions are restored.

Crow Reservation Impacts

Surface water impacts on Crow Tribal Lands under Alternative D are expected to include those impacts noted in Alternative B. Because the produced water would be treated prior to discharge, the reservation could expect impacts to surface water in the form of increased flow volume to the Bighorn, Little Bighorn, Rosebud, and Squirrel Creek watersheds from development on fee lands within the external boundary of the reservation. Groundwater effects would be similar to those detailed in Alternative B.

Northern Cheyenne Impacts

Surface water impacts on Northern Cheyenne Tribal Lands under Alternative D are expected to include those effects noted in Alternative B with the added effects from the surface discharge of 80 percent of the produced water from all of the Montana CBM wells forecast in the RFD in the Rosebud and Tongue River watersheds. Groundwater effects would include those detailed in Alternative B.

Conclusion

Treatment and discharge of produced water from Montana would not affect surface water quality, but would affect river flow volumes. Flow volumes in some watersheds would change only slightly, but some watersheds would see large flow increases, especially during times of traditionally low flow. The effects of these changes could include bank erosion, riparian area alteration, and loss of indigenous habitat. Effects to surface water flow would be similar to but slightly greater than for Alternative C, due to lower conveyance loss. Effects on Montana watersheds at the state line stations from Wyoming CBM discharge would be the same under this alternative as under Alternative A. The discharge of treated CBM water would dilute Wyoming CBM discharges as these waters flow further into Montana. Cumulative effects on surface water could include localized erosion and stream alteration. These effects would be similar to those caused by major rain events, but would be concentrated into small producing areas rather than spread over the entire watershed and last for the duration of the producing fields life.

Effects from surface impoundments would be similar to effects under Alternative C, except that produced water would be treated prior to storage, reducing the chances that the salinity of sub-soils and shallow, unconfined aquifers would be increased.

Drawdown effects to groundwater would be the same as under Alternative B.

Alternative E—Preferred Alternative

Water produced from CBM wells could be managed in a much broader fashion than has been analyzed in the previous alternatives by emphasizing beneficial use of CBM water and that MPDES requirements be met. A Water Management Plan (WMP) would be required prior to exploration or production. Water management options would include injection, treatment and discharge, impoundment, direct discharge, or any other operator proposed methods, provided that they are addressed in the WMP, the plan is approved by the appropriate agency, and MPDES requirements are met. The WMP must address both site-specific conditions and cumulative effects of proposed water management methods. The plan would address the proposed water management practices and their effects on soil, water, vegetation, wildlife, stream channel stability, and any other resources reasonably expected to be impacted by the actions. The WMP would be submitted in conjunction with Plans of Development (PODs), and would need to be approved prior to or concurrent with the approval of any Applications for permit to Drill (APDs).

Exploration

The volume of water generated by the testing of CBM exploration wells would be stored in tanks or lined (clay or geotextile) impoundments to be disposed of under the appropriate permits.

Production

Water would be produced by each of the 16,500 CBM wells expected to be developed in the CBM emphasis area. The maximum volume of CBM water would be produced during year 6 with lesser volumes before and after this period. Unlike Alternative C, the Preferred Alternative allows for wide latitude in produced water management. The combination of emphasizing beneficial use and increased flexibility for managing produced water would likely increase water used for beneficial purposes, such as stock watering, irrigation, dust control, etc. Increases in beneficial use would also result in decreased impacts resulting from surface discharge as compared to Alternative C. Because actual management practices are yet to be defined as far as the level of beneficial use and alternate water management practices (e.g., surface discharge), Alternative E assumes that 20% will be used beneficially.

Surface Water Analysis

The analyses that follow address the watersheds within the Montana portion of the Powder River Basin. Although other watersheds may be impacted around the state as a result of CBM development, the Powder River Basin is the area most likely to experience CBM activity. The Preferred Alternative management options would maintain the beneficial uses of existing surface water resources in the Montana portion of the Powder River Basin. It is assumed that surface discharge from Wyoming and Montana CBM would occur in each watershed until the resultant mixed water reaches the limits proposed for Montana streams. The remaining CBM water would be managed by other options including injection, treatment, infiltration or evaporation ponds, and beneficial use. The impact analyses calculate the expected effects on each watershed from the discharged CBM water, the amount of which varies from watershed to watershed. The final decision by the Montana Environmental Review Board may result in more or less stringent standards, in which case the amount of discharged CBM water would be altered so that surface water standards are met.

Tongue River

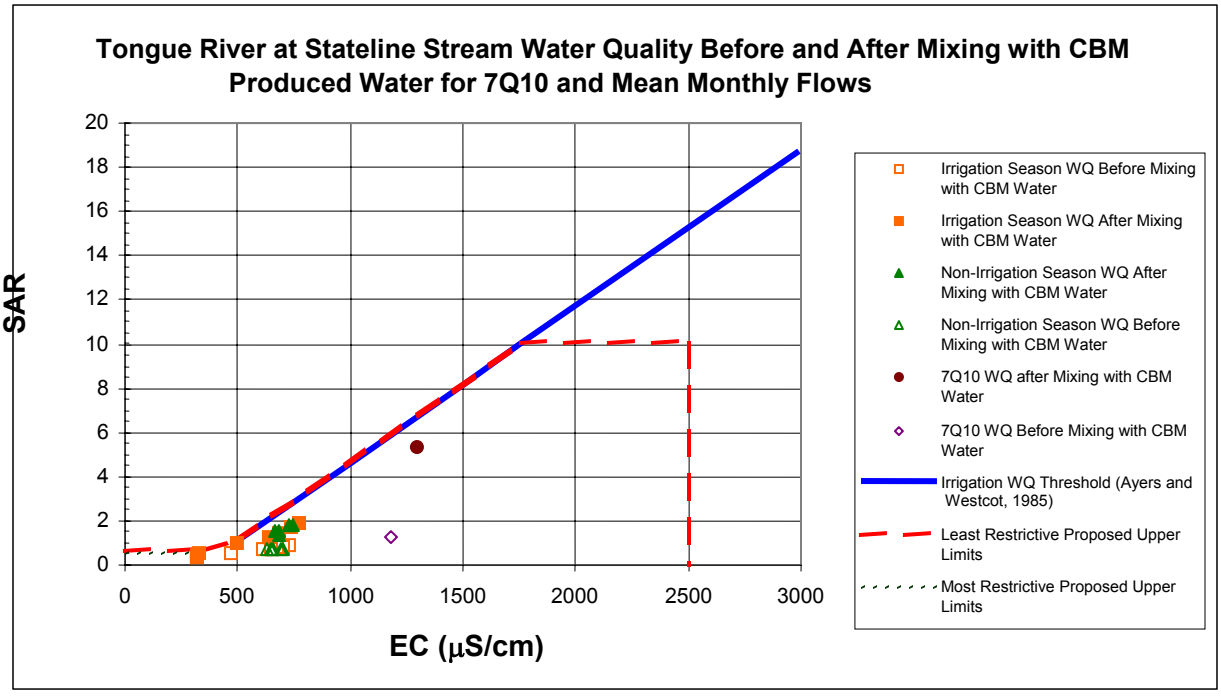
The Tongue River could be impacted by current and future CBM development in both the Wyoming and Montana portions of the Powder River Basin. As has been mentioned under previous alternatives, a detailed analysis for each station is provided in the SWQATR. The impact analysis discussed below is a summary of that analysis, using low mean monthly flows for comparison. This information for the Tongue River is summarized in Table 4-34.

Water quality before and after mixing for the Decker Station is shown graphically in Figure 4-2. In this figure water qualities before and after mixing are shown for low mean monthly flows. The resulting water qualities are plotted against several proposed limits as described at the beginning of the Hydrological Resources section. This diagram illustrates how the analysis for Alternative E was conducted. The volume of CBM water that could be discharged in Montana upstream from any station was calculated by beginning with the surface water chemistry and flow volume that would be expected at this station due to Wyoming discharges under their Alternative 2A. The volume of Montana CBM discharge assumed was then determined by increasing the volume until the LRPL was reached. The LRPL was chosen for this analysis as it represents the most severe impacts to surface water that can be reasonably

TABLE 4-34
EFFECTS ON SURFACE WATER FORECAST TO THE TONGUE RIVER UNDER THE PREFERRED ALTERNATIVE E

Station	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity (Min Mean Monthly) Under Alternative E		
	SAR	EC (µS/cm)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)
Tongue River at Stateline Near Decker	0.5	500	10	2500	178	0.86	731	183	1.93	773
Tongue River Near Birney Day School	0.5	500	10	2500	183	1.09	863	190	2.52	912
Tongue River at Brandenburg Bridge Near Ashland, Montana	0.5	500	10	2500	207	1.36	1016	214	2.5	1058

FIGURE 4-2
WATER QUALITY PLOT BEFORE AND AFTER MIXING WITH WYOMING'S ALTERNATIVE 2A AND MONTANA'S ALTERNATIVE E CBM DISCHARGES
TONGUE RIVER NEAR DECKER, MONTANA



expected given the data currently available. This should in no way be interpreted as an endorsement of this, or any, proposed standard by either the lead or cooperating agencies. The relationship between the resulting mixed waters with the proposed limits are discussed below:

- MRPLs: These limits are set at a SAR of 0.5 and an EC of 500 µS/cm for the Tongue River. Since the Tongue River naturally exceeds these limits for all but 2 months out of the average year, it cannot receive any CBM discharge if these limits are adopted. The forecasted impacts under Alternative E would be in excess of the these proposed limits.

- LRPLs: These proposed limits would be set at SAR of 10 and an EC of 2,500 µS/cm. These limits would not be exceeded during either the Minimum Mean Monthly or the 7Q10 flows under Alternative E.

- Northern Cheyenne Proposed Standards: Set at a SAR of 2.0 and an EC of 1,000 and 2,000 µS/cm at the south boundary of the Reservation. Surface water alteration forecasted under Alternative E would be below the Tribe's proposed limits except during 7Q10 flow.

- Ayers and Westcot 1985 water quality plot: The SWQATR discusses SAR versus EC plots as a way of determining potential impacts to soil texture after irrigation. The plot as shown in Figure 4-2 includes the boundary below which no impacts to soil are likely. Predicted water qualities during low mean monthly flows indicate that mixed waters will not cause infiltration impacts to soils under irrigation under Alternative E

The Tongue River is an important source of irrigation water in the Powder River Basin. The effects on the Tongue River would be the same as those for Alternative A, since no Montana CBM discharge to the Tongue would be assumed under this alternative analysis, besides discharge in accordance with the existing CX Ranch MPDES permit. This permit allows for 1,600 gpm of CBM discharge from up to 11 locations. Therefore, of the 33,282 gpm predicted to be produced during year 6 of the RFD, approximately 31,682 gpm will need to be managed by means other than surface discharge. This low level of surface discharge will not impact the beneficial uses of these surface waters.

As the impacts to other resources are dependent on the methods used to manage CBM produced water several additional assumptions needed to be made in order to conduct a meaningful analysis of Alternative E. As mentioned previously it is assumed that 20% of all produced water would be used for beneficial uses. For the Tongue River watershed this would be equal to 3,736 gpm being used for beneficial uses. It is then assumed that where it is physically possible to do so produced water will be managed via infiltration basins and injection wells. In this way the assimilative capacity of surface waters would be preserved for sites where it would not be possible to manage water through these methods. Since the geology necessary to conduct infiltration and injection operations will not be available at all sites it is assumed that 30% of all produced water will be managed through infiltration basins and 20% of all produced water will be managed by shallow injection. Within the Tongue River basin this would be equal to 5,604 gpm being managed through infiltration basins, and 3,736 gpm being managed through shallow injection. Next it is assumed that at sites where infiltration and injection are not possible the produced water would be discharged to surface waters to the degree allowed by the permitting process. For the Tongue River watershed this is equal to the 1,600 gpm currently allowed by the existing CX Ranch MPDES permit. Finally it is assumed that in cases where infiltration and injection are not possible, and discharge to surface waters can not be allowed, the remaining produced water will be managed equally by water treatment (such as reverse osmosis) and lined evaporation basins. For the Tongue River watershed this would be 2,002 gpm being managed by each of these means. A summary of these water management practices is presented in Table 4-35. This same distribution of water management practices is assumed for all watersheds analyzed. It should be noted that this distribution of water management practices is intended only for use in this analysis and is not intended to prescribe water management practices for any particular project. A site specific Water Management Plan will need to be developed for each project under Alternative E, and may include any, all, or none of the water management methods listed above.

As shown in Table 4-35, approximately 14,008 acres of surface disturbance are anticipated in the short term to accommodate produced water management in the Tongue River watershed. A total of 11,190 acres are estimated for long-term disturbance resulting from produced water management. The area of the Tongue River watershed is approximately 1.96 million acres (ALL, 2001b), this represents a short-term disturbance of 0.4 percent of the watershed, and a 0.3 percent long-term disturbance.

TABLE 4-35
WATER MANAGEMENT FRAMEWORK FOR THE TONGUE RIVER WATERSHED UNDER THE PREFERRED ALTERNATIVE E

Method	Volume to be Managed (gpm)	Rate Managed Per Site (gpm)	Number of Sites Needed	Acres Disturbed Short Term Per Site	Acres Disturbed Long Term Per Site	Cumulative Short Term Impacts	Cumulative Long Term Impacts
Beneficial Use	6,656	--	--	--	--	--	--
Infiltration Basins	9,984	9	1,142	6	5	6,852	5,710
Shallow Injection Wells	6,656	21	314	3	1	942	314
Surface Discharge	1600	150	11	0.01	0.002	1	1
Water Treatment	4,192	900	5	15	10	75	50
Evaporation Basins	4,192	4	1,023	6	5	6,138	5,115
Total	**33,282**					**14,008**	**11,190**

TABLE 4-36
EFFECTS ON SURFACE WATERS OF THE LITTLE BIGHORN AND BIGHORN RIVERS UNDER THE PREFERRED ALTERNATIVE E

	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity (Min Mean Monthly) Under Alternative E		
Station	SAR	EC (µS/cm)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)
Little Bighorn River at Wyola	0.5	500	10	2500	110	0.53	548	115	2.26 – 2.64	623-632
Little Bighorn River at Hardin	0.5	500	10	2500	123	0.99	768	133	3.94-4.59	881-896
Bighorn River at Bighorn	0.5	500	10	2500	1523	2.08	952	1542	2.54-2.64	968-970

Little Bighorn and Bighorn Rivers

The Bighorn River and its tributary, the Little Bighorn, are not expected to be affected by Wyoming CBM development, but are expected to be affected by CBM wells on Indian Lands and state and fee lands in Montana.

The resultant surface water impacts to the Bighorn Rivers would be similar to but less than Alternative C. This is due to the fact that the SQWATR indicates that approximately 60% of the produced water could be discharged in the upper portion of this watershed (Hardin and Wyola stations) without exceeding the LRPL. All projected produced water could be discharged in the downstream portion of the watershed (Bighorn station). The actual volume of water that is allowed to be discharged will depend on the final numeric water quality standards set by the Montana Board of Environmental Review, and the MPDES

permit program administered by the MDEQ. CBM discharge volumes will be dependent on site-specific conditions and the approval of a WMP. In order to be approved the WMP would need to show how the produced water could be managed without impacting beneficial uses. These results are shown in Table 4-36 and can be compared to the following surface water criteria:

- MRPL: The most restrictive proposed standards are set at a SAR of 0.5 and an EC of 500 μS/cm for the Bighorn Rivers. These criteria are exceeded by natural conditions in these rivers for several months out of the year. Thus, these rivers could not receive any CBM discharges if these standards were adopted. The forecasted impacts under Alternative E are therefore also in excess of these criteria.
- LRPL: The least restrictive proposed standards are set at a SAR of 10 and an EC of 2500 μS/cm. These criteria would only be exceeded during 7Q10 flows, and only at the upstream stations under this alternative.
- Ayers and Westcot: Predicted water qualities would only exceed this criterion during 7Q10 flows, and only at the upstream stations under this alternative.

There would be no impact to beneficial uses under this alternative.

Surface disturbance, as itemized in Table 4-37, indicates that approximately 1,516 acres of short term disturbance, and 1,129 acres of long term disturbance would result from water management practices under this alternative in this watershed of approximately 208,000 acres (ALL 2001b).

Rosebud Creek

Rosebud Creek is not expected to be affected by Wyoming CBM wells, and because Rosebud Creek contains such high quality water at such low flow rates, there is expected to be no discharge of Montana CBM water into Rosebud Creek under the analysis of the Preferred Alternative. For comparison purposes, these forecasted effects are summarized on Table 4-38.

The effects on Rosebud Creek would be the same as those for Alternative A, since no additional Montana discharges to Rosebud Creek are assumed under this alternative. A comparison to surface water quality criteria is provided in the discussion of Rosebud Creek under Alternative A. As there would be no discharge under this alternative there would be no degradation of beneficial uses. Table 4-39 provides an estimated of disturbances that would result from water management practices. By this estimate, approximately 11,217 acres of short-term surface disturbance will occur and approximately 8,987 acres of long term disturbance will occur. The drainage is approximately 814,000 acres in size (ALL 2001b).

Little Powder River

The effects on the Little Powder River surface water quality at the Weston, Wyoming, station would be the same as Alternative A, since there are no Montana wells discharging upstream of this station. The effects from Montana wells downstream of this station are calculated in the analysis for the Powder River at Locate station. The Preferred Alternative assumes untreated discharge of all anticipated CBM water in this watershed without impacting current beneficial uses. Local conditions could restrict this activity, and water management practices would need to be addressed and approved in a WMP.

Powder River

The Preferred Alternative E assumes that 100% of the Montana CBM water would be discharged to the watershed. The impacts to the Powder River watershed are shown in Table 4-40; impacts will come from discharges to the river from Wyoming CBM development as well as Montana development. These resulting surface water qualities can be compared to the following surface water criteria:

- MRPL: The most restrictive proposed standards are set at a SAR of 2 and an EC of 1000 μS/cm for the Powder River. The natural conditions in this river are well in excess of these criteria. Therefore this river could not receive any CBM discharges if these standards were adopted and the forecasted impacts under Alternative E are also in excess of these criteria.

TABLE 4-37
WATER MANAGEMENT FRAMEWORK FOR THE BIGHORN RIVER WATERSHED UNDER THE PREFERRED ALTERNATIVE E

Method	Volume to be Managed (gpm)	Rate Managed Per Site (gpm)	Number of Sites Needed	Acres Disturbed Short Term Per Site	Acres Disturbed Long Term Per Site	Cumulative Short Term Impacts	Cumulative Long Term Impacts
Beneficial Use	2,342	--	--	--	--	--	--
Infiltration Basins	1,874	9	208	6	5	1,248	1,040
Shallow Injection Wells	1,874	21	89	3	1	267	89
Surface Discharge	5,622	100	56	0.01	0.002	1	1
Water Treatment	0	900	0	15	10	0	0
Evaporation Basins	0	4.1	0	6	5	0	0
Total	**11,712**					**1,516**	**1,129**

TABLE 4-38
EFFECTS ON SURFACE WATER IN THE ROSEBUD CREEK UNDER THE PREFERRED ALTERNATIVE E

	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity (Min Mean Monthly) Under Alternative E		
Station	SAR	EC (µS/cm)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)
Rosebud Creek at Kirby	1	500	10	3000	1.78	0.77	1016	1.78	0.77	1016
Rosebud Creek at Rosebud	1	500	10	3000	8.42	4.84	1780	8.42	4.84	1780

TABLE 4-39
WATER MANAGEMENT FRAMEWORK FOR THE ROSEBUD CREEK DRAINAGE UNDER THE PREFERRED ALTERNATIVE E

Method	Volume to be Managed (gpm)	Rate Managed Per Site (gpm)	Number of Sites Needed	Acres Disturbed Short Term Per Site	Acres Disturbed Long Term Per Site	Cumulative Short Term Impacts	Cumulative Long Term Impacts
Beneficial Use	4,912	--	--	--	--	--	--
Infiltration Basins	7,367	9	842	6	5	5,052	4,210
Shallow Injection Wells	4,912	21	232	3	1	696	232
Surface Discharge	0	100	0	0.01	0.002	0	0
Water Treatment	3,684	900	5	15	10	75	50
Evaporation Basins	3,684	4.1	899	6	5	5,394	4,495
Total	**24,559**					**11,217**	**8,987**

TABLE 4-40
EFFECTS ON SURFACE WATER IN THE POWDER RIVER UNDER THE PREFERRED ALTERNATIVE E

Station	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity (Min Mean Monthly) Under Alternative E		
	SAR	EC (µS/cm)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)
Powder River at Moorhead	2	1000	10	3000	145	4.65	2154	231	11.08 - 11.56	2226 - 2253
Powder River at Locate	2	1000	10	3000	143	4.61	2287	250	11.97 – 13.13	2323 - 2361

- LRPL: The least restrictive proposed standards are set at a SAR of 10 and an EC of 3200 µS/cm. According to this surface water model these criteria would be exceeded during 5 of the 12 months of the average year as well as 7Q10 flows under this alternative, with the majority of this alteration being due to CBM discharges in Wyoming.
- Ayers and Westcot: This criterion would only be exceeded during 7Q10 flows under this alternative.

The Powder River watershed is unique to the PRB in Montana; the existing water is seasonally variable and often of low quality, there is significant CBM discharge to this river in Wyoming at the present time that does not appear to be impacting the river [see Appendix E in the SWQATR Greystone, 2002)], and CBM water quality data in the Montana portion of the watershed is limited. For these reasons the possibility for 100% discharge is assumed. Of course site-specific conditions and the actual surface water standards adopted by the Montana Board of Environmental Quality will be the most important factors in determining the actual water management practices within the Montana portion of the PRB. The MDEQ cannot allow discharges of CBM water to impact surface water conditions in excess of prevailing regulations and standards. This process may require the use of other water management practices such as water treatment or infiltration basins in this watershed. CBM producers in the Wyoming portion of this watershed will be held to the same standards once the Montana standards are approved by the EPA and given Clean Water Act standing.

In order to manage the Montana CBM discharge, approximately 1.0 acre of short term, and 1.0 acre of long term disturbance would occur in the Powder River watershed, which has a total area of approximately 368,500 acres. (ALL 2001b).

Mizpah Creek

Table 4-41 illustrates the small amount of water within Mizpah Creek. Only 125 Montana CBM wells are projected to be productive in this watershed; and there are no Wyoming CBM wells. Impacts are expected to be the same under Alternative E as under Alternative A, since no CBM produced water could be discharged under this alternative. The surface disturbing activities associated with water management in the Mizpah watershed is included in the water management framework for the Powder River watershed (Table 4-42) and also analyzed separately for the Mizpah watershed on Table 4-43.

Beneficial uses would not be reduced.

The water management scenario is detailed in Table 4-43. The necessary discharge facilities would require approximately 201 acres of short-term disturbance and 159 acres of long-term disturbance in a watershed of approximately 24,000 acres (ALL 2001b).

Yellowstone River

The Yellowstone River receives the combined flows of all the other watersheds in the Montana portion of the Powder River Basin. The Forsyth station is the upstream station which receives no contribution from Wyoming discharges, but will receive some MT CBM discharge. The Sidney station is the downstream station and it will receive discharges from all Montana

Powder River Basin wells and approximately 21,391 CBM wells from the Wyoming portion of the Powder River Basin under Alternative E. The effects to the Yellowstone River would be less than those indicated for Alternative C as the volume of CBM water discharged to tributaries of the Yellowstone would be limited. Table 4-44 summarizes the effects of these discharges on the Yellowstone River. These resultant surface water chemistries can be compared to the following criteria.

- MRPL: The most restrictive proposed standards are set at a SAR of 0.5 and an EC of 500 μS/cm for the Yellowstone River. These criteria are exceeded by natural conditions in this river for several months out of the year. Thus, this river could not receive any CBM discharges if these standards were adopted. The forecasted impacts under Alternative E are therefore also in excess of these criteria.

TABLE 4-41
EFFECTS ON SURFACE WATERS OF MIZPAH CREEK DRAINAGE UNDER THE PREFERRED ALTERNATIVE E

	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity (Min Mean Monthly) Under Alternative A		
Station	**SAR**	**EC**	**SAR**	**EC**	**Flow**	**SAR**	**EC**	**Flow**	**SAR**	**EC**
Mizpah Creek at Mizpah	3	1000	10	3000	0.26	16.6	3503	0.26	16.6	3503

TABLE 4-42
WATER MANAGEMENT FRAMEWORK FOR THE POWDER RIVER WATERSHED UNDER THE PREFERRED ALTERNATIVE E

Method	Volume to be Managed (gpm)	Rate Managed Per Site (gpm)	Number of Sites Needed	Acres Disturbed Short Term Per Site	Acres Disturbed Long Term Per Site	Cumulative Short Term Impacts	Cumulative Long Term Impacts
Beneficial Use	1,765	--	--	--	--	--	--
Infiltration Basins	0	9	0	6	5	0	0
Shallow Injection Wells	0	21	0	3	1	0	0
Surface Discharge	7,058	100	71	0.01	0.002	1	1
Water Treatment	0	900	0	15	10	0	0
Evaporation Basins	0	4	0	6	5	0	0
Total	**8,823**					**1**	**1**

TABLE 4-43
WATER MANAGEMENT FRAMEWORK FOR THE MIZPAH CREEK DRAINAGE UNDER THE PREFERRED ALTERNATIVE E

Method	Volume to be Managed (gpm)	Rate Managed Per Site (gpm)	Number of Sites Needed	Acres Disturbed Short Term Per Site	Acres Disturbed Long Term Per Site	Cumulative Short Term Impacts	Cumulative Long Term Impacts
Beneficial Use	82	--	--	--	--	--	--
Infiltration Basins	123	9	14	6	5	8	70
Shallow Injection Wells	82	21	4	3	1	12	4
Surface Discharge	0	100	0	0.01	0.002	0	0
Water Treatment	61	900	1	15	10	15	10
Evaporation Basins	61	4	15	6	5	90	75
Total	**409**					**201**	**159**

TABLE 4-44
EFFECTS ON SURFACE WATER IN THE YELLOWSTONE RIVER UNDER THE PREFERRED ALTERNATIVE E

	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity (Min Mean Monthly) Under Alternative E		
Station	SAR	EC (µS/cm)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)
Yellowstone at Forsyth, Montana	0.5	500	10	2500	5820	1.99	745	5850	2.22 – 2.18	753 – 754
Yellowstone at Sidney, Montana	0.5	500	10	2500	5764	2	870	5850	2.54 – 2.60	891 – 893

- LRPL: The least restrictive proposed standards are set at a SAR of 10 and an EC of 2500 µS/cm. All mixed water qualities are below these limits.
- Ayers and Westcot: Predicted water qualities would not exceed this criterion even during 7Q10 flows.

Although discernable effects may be seen at Forsyth and Sidney, beneficial uses would not be reduced under Alternative E.

The overall assumed water management practices for the Montana portion of the Powder River Basin, all of which is drained by the Yellowstone River, is presented in Table 4-45. Approximately 37 percent of the water produced would recharge local aquifers through infiltration and injection under this alternative. The short-term surface disturbances caused by various water management practices in the Montana portion of the basin include approximately 26,867 acres, while the long-term disturbances are approximately

TABLE 4-45
WATER MANAGEMENT FRAMEWORK FOR THE YELLOWSTONE WATERSHED UPSTREAM SIDNEY, MT (ALL OF THE MONTANA PRB) UNDER THE PREFERRED ALTERNATIVE E

Method	Volume to be Managed (gpm)	Rate Managed Per Site (gpm)	Number of Sites Needed	Acres Disturbed Short Term Per Site	Acres Disturbed Long Term Per Site	Cumulative Short Term Impacts	Cumulative Long Term Impacts
Beneficial Use	15,757	--	--	--	--	--	--
Infiltration Basins	19,348	9	2,206	6	5	13,160	11,030
Shallow Injection Wells	13,524	21	639	3	1	1,917	639
Surface Discharge	14,280	100	138	0.01	0.002	3	3
Water Treatment	7,937	900	11	15	10	165	110
Evaporation Basins	7,937	4	1937	6	5	11,622	9,685
Total	**78,783**					**26,867**	**21,467**

21,467 acres. The total acreage of the area is approximately 4.1 million acres (ALL 2001b). The short-term disturbances total approximately 0.65 percent of the total Montana PRB area, the long-term disturbances total even less.

Summary of Surface Water Impacts

A summary of calculated surface water effects by USGS station for the preferred alternative is shown in Table 4-46.

The table summarizes effects of forecast discharges of CBM water from the Wyoming Alternative 2A and Montana Preferred Alternative E for watersheds in the Montana portion of the Powder River Basin. Surface water quality in some watersheds would be slightly reduced; however, downstream uses would not be diminished. Surface water flow would be moderately increased causing some riparian erosion, as well as increased sedimentation.

Abandonment

Impacts to water resources due to abandonment operations would be similar to impacts under Alternative B. When the estimated 16,500 CBM production wells are abandoned over the 20-year project life, 33,000 acres of soil would be disturbed and reclaimed. This disturbed soil would be vulnerable to erosion and the resulting suspended material could be washed into adjacent surface waters unless mitigating measures are employed. The implementation of BMPs would reduce soil erosion until groundcover and original conditions are restored.

Crow Reservation

Surface water effects on Crow Tribal Lands under Alternative E would be similar to, but less than, those effects noted in Alternative C. Because of the latitude in produced water management, effects would be lessened by the wider variety of water management options. Groundwater effects within the reservation boundary would be identified and controlled by monitoring and production restrictions. The monitoring would track drawdown of aquifers from CBM production on federal leases outside the reservation boundary. If drawdown is detected, the production rate of CBM wells on federal leases would be restricted.

Northern Cheyenne

Surface water effects to Northern Cheyenne Tribal Lands under Alternative E (Preferred Alternative) would be similar to those impacts noted in Alternative A, since no additional direct discharge of CBM water is assumed occur into the Tongue River or Rosebud Creek. The beneficial use of the Tongue and Rosebud streams would be maintained under Preferred Alternative E.

CBM developments have the potential to impact groundwater resources under Northern Cheyenne Tribal Lands. Groundwater impacts within the reservation boundary would be detected and managed by monitoring the magnitude of aquifer drawdown.

TABLE 4-46
CUMULATIVE IMPACTS ON SURFACE WATERS UNDER WYOMINGS' ALTERNATIVE 2A AND MONTANAS' ALTERNATIVE E

Station	Most Restrictive Proposed Limits (MRPL)		Least Restrictive Proposed Limits (LRPL)		Existing Stream Water Quality and Quantity (Min Mean Monthly)			Resulting Stream Water Quality and Quantity (Min Mean Monthly)		
	SAR	EC (µS/cm)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)	Flow (cfs)	SAR	EC (µS/cm)
Tongue River at Stateline Near Decker	0.5	500	10	2500	178	0.86	731	183	1.93	773
Tongue River Near Birney Day School	0.5	500	10	2500	183	1.09	863	190	2.52	912
Tongue River at Brandenburg Bridge Near Ashland, Montana	0.5	500	10	2500	207	1.36	1016	214	2.5	1058
Little Bighorn River at Wyola	0.5	500	10	2500	110	0.53	548	115	2.26 – 2.64	623 - 632
Little Bighorn River at Hardin	0.5	500	10	2500	123	0.99	768	133	3.94- 4.59	881-896
Bighorn River at Bighorn	0.5	500	10	2500	1523	2.08	952	1542	2.54- 2.64	968-970
Rosebud Creek at Kirby	1	500	10	3000	1.78	0.77	1016	1.78	0.77	1016
Rosebud Creek at Rosebud	1	500	10	3000	8.42	4.84	1780	8.42	4.84	1780
Little Powder River Stateline Weston,	3	1000	10	3000	2.6	6.94	3300	16	10.41	1606
Powder River at Moorhead	2	1000	10	3000	145	4.65	2154	231	11.08 – 11.56	2226 - 2253
Powder River at Locate	2	1000	10	3000	143	4.61	2287	250	11.97 – 13.13	2323 - 2361
Mizpah Creek at Mizpah	3	1000	10	3000	0.26	16.6	3503	0.26	16.6	3503
Yellowstone at Forsyth, Montana	0.5	500	10	3000	5820	1.99	745	5850	2.18 – 2.22	753 – 754
Yellowstone at Sidney, Montana	0.5	500	10	3000	5764	2	870	5850	2.54 – 2.60	891 - 893

The monitoring wells would be engineered and placed to best intercept drawdown effects from CBM development. Nests of monitoring wells will be used to track drawdown of multiple producing coal seams. To this end, the USGS is currently installing six well clusters along the southern boundary of the Northern Cheyenne Reservation to track drawdown effects from CBM development east of the CX Ranch and nearby areas. The BLM is also installing monitoring well clusters throughout the Montana portion of the Powder River Basin, including areas adjacent to the Northern Cheyenne and Crow Reservations. The BLM wells will provide regional hydrological information as well as locally important data. In addition, CBM operators may be required to install additional monitoring wells adjacent to proposed producing wells. The entire monitoring well network would monitor drawdown of coal seams and surface aquifers due to CBM production on federal, state, and fee leases outside the reservation boundary. Monitoring well data would be

placed in the public record by the USGS, the BLM, and responsible state agencies where it can be accessed and used by Tribal officials as well as agency staff.

If drawdown is detected on the Reservation, the production rate of CBM wells operated on federal leases would be restricted until mitigation measures can be put into place. Mitigation measures could include curtailment of CBM production, replacement of affected water wells or springs, or a hydrologic barrier engineered to reduce additional drawdown. The BLM would use all reasonable means to assure that Reservation groundwater is not adversely affected by off-Reservation CBM production. Mitigation measures would substantially reduce drawdown originating from federal mineral leases, but the potential still exists for CBM wells on nearby state and fee leases to drawdown groundwater within the reservation boundaries.

Conclusion

Effects of the Preferred Alternative to groundwater will be the same as Alternative B. Minor effects on shallow groundwater quality from impoundment infiltration and surface discharge of some untreated production water would also occur. The operator's WMPs would result in increased beneficial use of produced CBM water, estimated to total at least 20 percent.

Surface water effects would be the same as Alternative A for the Tongue River, Rosebud Creek, Little Powder River, and Mizpah stations. Surface water effects would be the same as Alternative C for the Powder River. Effects to the Yellowstone, Little Bighorn, and Bighorn rivers would be similar to, but less than, those identified under Alternative C. Even where discharge is an available option operators may choose other options when managing their CBM water with simultaneous reductions in the volume of surface discharge. Consultation with state and federal agencies charged with managing Wyoming's resources have allowed close cooperation and improved estimation of likely impacts to the surface waters of Montana from CBM and other activities under this alternative. The cumulative impacts to surface water and groundwater further depend upon WDEQ's and MDEQ's Water Quality Agreement, as well as MDEQ non-degradation numerical standards. Anticipated impacts under this alternative include slight alteration of surface water quality, without diminishing downstream use.

Weathered landscape with exposed Fort Union Formation

Indian Trust and Native American Concerns

Indian Trust Assets
Indian Trust Assets (ITAs) are official interests in assets held in trust by the federal government for Indian tribes or individuals. The U.S. Department of the Interior (DOI) Departmental Manual 303 DM 2 defines ITAs as lands, natural resources, money, or other assets held by the federal government in trust or that are restricted against alienation for Indian tribes and individual Indians.

Alternative A
No Action (Existing CBM Management)

- No measurable impacts to Indian trust impacts would occur from the CBM activities.

Alternative B
CBM Development with Emphasis on Soil, Water, Air, Vegetation, Wildlife and Cultural Resources

- Federal:
  - No surface water quality impacts.
  - Potential CBM drainage, dependent on specific site conditions, delayed by buffer zone.
  - Air Quality impacts to reservation PSD Class I areas.
  - Visibility impacts.
  - Potential cultural resource impacts to TCPs
- State:
  - Groundwater drawdown inward from reservation boundaries.
  - Potential CBM drainage, dependent on specific site conditions, no delay due to adjacent development.

Alternative C
Emphasize CBM Development

- Federal:
  - Potential for surface water quality and quantity impacts.
  - Potential CBM drainage, same as Alternative B.
  - Cultural Resource impacts same as B.
  - Air quality and visibility impacts same as Alternative B.
- State:
  - Groundwater drawdown same as Alternative B.
  - Surface water quality and quantity impacts.
  - Potential CBM drainage, same as Alternative B.

Alternative D
Encourage CBM Exploration and Development While Maintaining Existing Land Uses

- Federal:
  - Groundwater drawdown same as Alternative B.
  - Surface water quality impacts reduced by source treatment, increased availability of surface waters for irrigation and other beneficial uses
  - Increased surface water flow could in increase riparian erosion.
  - Potential CBM drainage, same as Alternative B.
  - Cultural Resource impacts same as B.
  - Air Quality and visibility impacts reduced.
- State:
  - Groundwater drawdown same as Alternative B.
  - Surface water quality impacts reduced.
  - Potential CBM drainage, same as Alternative B.

Alternative E
Preferred CBM Development Alternative

- Federal:
  - Effects from groundwater drawdown substantially reduced by resource protection protocols. Potential CBM drainage mitigated or compensated.
  - Surface water quality impacts reduced, with increased availability of surface waters for irrigation and other beneficial uses.
  - Increased surface water flow could increase riparian erosion.
  - Air Quality impacts mitigated through site specific permits and control measures.
- State:
  - Groundwater drawdown potential on the reservations would be minimized. CBM drainage minimized by state spacing.
  - Surface water quality protected.

Assumptions

The BLM's responsibilities include identifying and protecting Tribal resources and trust assets from impacts resulting from BLM actions. The state does not have a trust responsibility similar to the federal governments. The 2-mile buffer zone around the reservations as called for in the management objectives for Alternatives B and D would only apply to federal leases.

Impacts From Management Common to All Alternatives

While the BLM would not have jurisdiction over Indian lands located on or off the reservation, the BLM would have a trust responsibility that encompasses oil and gas exploration. Indian Trust Assets (ITAs) would be managed following the DOI Secretarial Order 3215, Principles for the Discharge of the Secretary's Trust Responsibility.

The conventional wells expected to be drilled on BLM-administered lands could impact adjacent reservation lands by draining tribal hydrocarbons or groundwater, or even by allowing produced water to impact surface water resources or soil. Drainage by adjacent wells is addressed by 43 CFR Part 3162.2-2, which instructs the BLM on steps to be taken to protect Indian landowners from drainage.

The number of conventional wells estimated for reservation development (12) coupled with the predicted wells (less than 25) adjacent to reservation lands, do not represent a measurable increase in development on or near the reservation for the next 20

years. This level of development would not impact tribal hydrocarbons or effect groundwater resources. The direct land impacts from this small number of wells on reservation lands would be minor (less than 75 total acres impacted) with regard to grazing lands, vegetation, and biological resources.

Impacts From Management Specific to Each Alternative

Alternative A—No Action (Existing CBM Management)

There would not be any impacts to measurable ITAs from the CBM activities planned under this alternative.

This is based on the limited development scenario under this alternative, the known locations of production wells (CX Ranch), and the number of exploration wells..

Conclusion

There would not be any impacts to ITAs from management decisions under Alternative A or from management practices common to all alternatives. Cumulative effect impacts could result from the Absaloka Coal Mine and the production and discharge of CBM production waters from Wyoming.

Mining activities at the 5,400-acre Absaloka Coal Mine facility located just north of the northeastern corner of the Crow Reservation has resulted in the irretrievable loss of the coal mined at approximately 5 million tons per year, and has removed or disturbed approximately 3,150 acres of topsoil. Additional impacts have occurred from the dewatering of the coal that lowered the surrounding groundwater by an estimated 75 feet (Wheaton and Van Voast 1998). Finally, the surface water within the vicinity of the mine has undergone a reduction in quality, resulting in impacts on the local watercourses and subsequent fields using these waters as sources of irrigation.

Development of CBM in Wyoming during the next 20 years has the potential to impact the surface water, groundwater, and methane resources of the Crow and Northern Cheyenne tribes. Drawdown of groundwater levels is an unavoidable impact from CBM development. Increased groundwater drawdown would be experienced in coal seam aquifers along the southeastern border of the Crow Reservation adjacent to and up to 5 miles north of the Wyoming state line (Wheaton and Metesh 2001). The magnitude of impact to water wells and springs would depend on the location and number of CBM producing wells south of the state boundary. Depending upon their locations, natural springs and water wells on tribal lands could go dry.

Wyoming CBM production could also drain methane from tribal mineral resources. As groundwater is drawn down and reservoir pressures decrease, methane is liberated from the coal matrix and becomes free to be produced or migrate. Two- dimensional modeling (Crockett and Meyer 2001) suggests that drainage of methane could occur at distances more than 5 miles from a producing CBM field. Recent three-dimensional modeling suggests that the methane drainage effect is less than 2 miles. This is based on the model results indicating that 80 feet of water would be drawn down at 2 miles from the edge of a producing field (Wheaton and Metesh 2002). In either case, the Crow Reservation is adjacent to the Wyoming boundary and is close enough to be drained by CBM wells that may be drilled in Wyoming.

Full-scale CBM production in the Wyoming portion of the Powder River Basin would result in limited surface discharge and infiltration of produced water to streams that flow north into Montana. Expected levels of development would result in volumes of discharged water causing a slight increase in annual flow rates of the Powder, Little Powder, and Tongue Rivers. A corresponding slight alteration in the quality of surface water would also be felt downstream from these Wyoming discharges. The percent increase in flow volume would be greater during periods of low-flow. This alteration may require downstream users to implement minor management changes. Impacts to the Tongue Rivers would be felt by the Northern Cheyenne and Crow members who use river water for irrigation. Detailed discussions regarding surface water quality and flow changes are presented in the Hydrologic Resources section of this chapter.

The Bighorn and Little Bighorn rivers carry high quality water from the Bighorn Mountains north into Montana. No CBM wells in Wyoming or Montana would impact these rivers under Alternative A. Stream water quality and flow volume would remain unchanged.

The Northern Cheyenne have a large reserved water right in the Tongue River Reservoir. That stored water represents a marketable commodity and if it were to experience even a slight decrease in quality, it would affect the tribes' ability to market or use the water. Under this full-scale Wyoming development scenario, it is conceivable that the reservoir water quality could be slightly altered.

Alternative B—Emphasize Soil, Water, Air, Vegetation, Wildlife, and Cultural Resources

Based on the development scenario presented in Alternative B and on the management objectives described under this alternative, potential impacts on ITAs include the drawdown of groundwater, alterations in surface water quality, air quality changes, potential social and cultural impacts, potential wildlife adaptation, and the drainage of Tribal CBM.

A 20 foot drawdown of the groundwater table within the vicinity of a producing Montana CBM field has been modeled (3D) by the MBMG at between 4 to 5 miles from the edge of production (Wheaton and Metesh 2002). Without site-specific information, it is impossible to predict the degree of drawdown to a neighboring aquifer. In the case of the Crow and Northern Cheyenne, it is conceivable that the reservations' groundwater would be drawn down to some extent along the boundaries by both state and BLM-leased development. The drawdown of groundwater within the reservation could result in impacts on shallow stock and domestic wells and some surface springs. These impacts would reduce water pressure and in some cases could render the complete loss of water from a well or spring.

The recognition of a 2-mile buffer zone around the reservations would effectively reduce and delay the drawdown that would be experienced by the tribes in these areas from BLM leased mineral development. In the case of development on either private or state fee lands, the state would not be subject to the same buffer zone restrictions, and therefore, the drawdown could be generated earlier and be to a greater horizontal and vertical extent. The effect of these combined drawdowns would create a long-term impact to the groundwater level.

The alteration of surface water quality from the management objectives in this alternative is almost negligible because the alternative calls for the injection of all produced water and the storage of all waters generated during exploration well tests. However, the potential exists for localized, short-term (less than 1 year) impacts from spills and ruptures associated with these water disposal methods. Undetected ruptures along water conduits feeding injection wells also would impact soils and create erosion problems within the immediate vicinity. These impacts are not expected to reach reservation lands under this management objective. Only the spilled or released waters entering associated watersheds near the reservations would be affected.

Numerous social and cultural impacts have been predicted by Native Americans as a result of CBM development on adjacent fee, state, and federal minerals. These potential impacts include the lack of access to well-paying energy-related employment contributing to the reduced annual Native American income; over-commitment of Tribal revenues; population influx; abridged effectiveness of Tribal governments; stressed infrastructure and service-related capacity; altered social organization and social well-being perception; and the further influence of western culture resulting in changes to traditional belief and value systems.

Off-reservation cultural and paleontological artifacts also run the risk of being damaged or lost due to the increased access and land-disturbing activities associated with full-scale development. TCPs may be affected as development expands. These impacts would be minimized through survey and consultation with the tribes.

Wildlife would adapt to the CBM development infrastructure in ways that could be interpreted as negative or positive. For example, depending on one's perspective, big game migratory paths could shift resulting in greater opportunities for tribal outfitters and tribal hunters or diminished chances for euro-American outfitters and hunters. This scenario could result in reduced herd strength or increased susceptibility could also be viewed as a negative outcome or singularity. Given the various and complex perspectives, wildlife impacts need to be assessed on a case-by-case basis as individual CBM actions are reviewed.

CBM development would threaten to drain methane resources under tribal lands in the planning area. Drainage of CBM resources from Native American minerals is dependent upon local reservoir parameters. It is assumed that a single CBM well would drain the methane from a single coal seam over an 80-acre unit. Research by the BLM in the Wyoming portion of the Powder River Basin, however, suggests that drainage may be across a broader radius (Crockett and Meyer 2001) from BLM, private, or state lands. The Wyoming BLM estimates that considerable methane drainage happens when 40 percent of the hydrostatic head is removed from the coal aquifer. Modeling by the MBMG (Wheaton and Metesh 2002) suggests that the hydrostatic head of a producing coal seam could be reduced sufficiently to cause methane liberation at a distance of approximately 2 miles from the edge of a producing CBM field. The reduction of hydrostatic pressure achieved by lowering the water table within a specific coal seam is necessary for CBM production. This reduction liberates the methane held in the coal

matrix; however, the complex, site-specific aquifer conditions dictate the actual radius of methane drainage. Therefore, conclusions regarding methane drainage from tribal minerals need to be made on a case-by-case basis during development.

The reduction of the hydrostatic pressure in a coal seam and the resulting liberation of CBM could also cause the methane to migrate along the path of least resistance and appear as an unchecked seepage at the surface. This scenario would be unlikely in view of the depths of the coal seams being explored (greater than 500 feet below the ground surface), the distance of foreseeable producing fields to the reservations and the relatively shallow groundwater wells used on the reservations for water production.

This alternative calls for the directional drilling of deeper coal seams, multiple completions in a single well bore, and the simultaneous development of all coal seams within a field. These techniques would increase the likelihood that CBM would be drawn from adjacent Indian mineral resources. Detailed explanations for these potential impacts can be found in the Hydrology, Geology and Minerals, and Air Quality sections of this Chapter.

Mitigation agreements would be used to replace water lost from the drawdown of groundwater within aquifers impacted by CBM production. These agreements would call for the replacement of the groundwater wells at the operator's expense. Another mitigation measure for large-scale groundwater drainage to the reservations is the installation of a hydraulic barrier between the production field and the reservation boundary. BLM would apply this mitigation measure to reduce and delay any water drainage from the Indian reservations. Although hydraulic barriers have been used successfully to prevent migration of brackish or salty waters into drinking water resources, more research would be required to determine if they could be employed successfully in the coal seam aquifers of the Powder River Basin to prevent loss of groundwater resources.

Surface water discharge permits that limit the quantity of CBM-produced water that is discharged would mitigate the impacts from Wyoming CBM production, as well as from expanded CX Ranch production. Potential hydrocarbon migration would be the subject of detailed monitoring and periodic drainage analysis conducted by the BLM as part of their trust responsibility (See Monitoring Appendix for details and frequency of monitoring). Monitoring and conducting drainage analysis would reduce the likelihood for drainage of Tribal CBM resources. Native American development of reservation CBM resources is another potential mitigation measure that would ensure the Tribes receive their fair share of the CBM revenues.

Conclusion

Impacts from management decisions included in Alternative B, would result in impacts to surface water quality, groundwater availability, cultural artifacts and sites, wildlife, air quality, visibility, and the irreversible loss of fluid and solid minerals.

The surface water quality impacts would be similar to those described under Alternative A, with only slight alterations to current quality.

The water drawdown from Montana CBM development under Alternative B, coupled with the development of CBM on the reservations, would result in a more widespread effect than just adjacent to the reservation boundaries. Considering the location of known coal occurrences, the groundwater drawdown would be experienced generally along the eastern portion of the Crow Reservation and across the entire Northern Cheyenne Reservation. The water drawdown would be contingent on the continuity of the coals, many of which are fractured, crop out, pinch out or have shale stringers. Impacts could not be detailed until the fields are developed. Under any scenario of development, the BLM would take measures to mitigate reservation groundwater drawdown resulting in no contributing influences from federal mineral development.

Associated with the development of full-scale CBM production across the Powder River Basin are a network of gas compressors and other small emission sources that could contribute to air quality changes in the region. The non-project sources combined with the project sources to form a cumulative effect that contributions to changes in air quality. These changes could add to the pollutant concentration, possibly exceeding the Northern Cheyenne's PSD Class I area for the annual NO_2 and 24-hour PM_{10} increment standards. If site- specific analysis indicates these contributions would add to the pollutant concentration on the Lame Deer nonattainment area resulting in an exceedance, the tribe, state and the Federal Government would require mitigation measures to reduce and control the contributing sources of CBM emissions.

The Crow Reservation would experience similar changes in air quality, but due to the reservation's classification as a PSD Class II area would not likely experience any exceedance of standards.

With regards to visibility, the air model indicates that the Crow and Northern Cheyenne, as well as the Fort Belknap reservation, would experience some form of reduced vision or increased haze. Visibility impacts would increase under predicted cumulative impacts from project and non-project emissions. For more detailed discussions regarding Air Quality changes to the reservations see the Air Quality section of this chapter.

Potential effects to cultural artifacts, TCPs, and wildlife would be mitigated by site-specific protective and control measures developed to reduce and/or eliminate detrimental changes.

Alternative C—Emphasize CBM Development

The differences in management objectives for Alternative C that would affect ITAs are the direct discharge of a portion of untreated production water, and to some extent, the removal of the directional drilling and multiple completion requirements. Impacts to air quality, visibility, cultural resources, wildlife, and social services and infrastructure would be the same or similar to those described for Alternative B.

Important to note is that, depending on the water quality criteria developed by the MDEQ, various levels of impacts on surface water would occur. If the criteria imposed were to be relatively conservative, the discharge of CBM produced water would be limited into watersheds of both low and high water quality, resulting in minimal surface water quality impacts and increased treatment and use of alternative disposal methods. On the other hand, if the criteria were to be somewhat liberal and allow untreated discharge of produced CBM water into watersheds of higher quality, then impacts such as the following would be experienced: increased soil erosion and a corresponding increase in the addition of suspended sediment to surface waters adjacent to CBM development; the elevation of existing SAR, EC, and bicarbonate values for streams and rivers used by the tribes for irrigation; and the increase in flow that would result in riparian erosion and river course changes. These impacts are discussed in further detail in the *Hydrology* section of this chapter.

Impacts on groundwater would consist of the same drawdown effects as described in Alternative B. The development of federal minerals near the reservations would increase the rate at which the groundwater is removed and discharged to the surface. Additionally, impacts on shallow aquifers from the infiltration of untreated produced water are expected where the soils have a coarser texture (sandy to loamy) and good internal drainage (ALL 2001a), which would allow infiltration of produced water into subsoil-thereby impacting shallow aquifers. Some of the shallow aquifers adjacent to reservation boundaries would be affected by this type of short-term infiltration.

The discharge of untreated produced water into drainages and ephemeral watercourses adjacent to well sites would cause an overall increase in erosion leading to gullying. Based on the *Soils Technical Report* (ALL 2001a), much of the soil would likely be susceptible to increasing sodicity when irrigated or land applied with water having a high SAR (generally greater than 12). The long-term consequence is an anaerobic, waterlogged, saline/sodic soil that can be reclaimed, but would be very difficult to mitigate.

Drainage of Native American CBM resources by adjacent production would be similar to that described for Alternative B for adjacent production. Site-specific conditions control methane liberation and collection and therefore, to evaluate potential drainage, a case-by-case drainage determination is necessary.

Encroachment on the Absaloka Coal Mine by CBM development would inhibit future coal resource recovery. Impacts associated with the groundwater drawdown would also occur. This is discussed further in the *Geology and Minerals* section of this chapter.

Conclusion

Impacts from management decisions included in Alternative C would result in impacts to surface water quality. State and fee development would reduce groundwater availability and cause the irreversible loss of fluid minerals.

The impacts to surface water quality would be greater than described in Alternative B, but the biggest factors influencing water quality would be the creation of a Water Quality Agreement between Montana and Wyoming, and the implementation of water quality criteria regarding degradation of Montana watersheds by the DEQ. CBM development on reservations would further increase the SAR value of available surface waters, adding to the chain reaction of impacts associated with erosion, sedimentation, riparian damage, and land use applications.

Impacts on the Northern Cheyenne's water right in the Tongue River Reservoir would be as described under Alternative A.

Impacts on groundwater drawdown and availability would be similar to those explained under Alternative B. Drawdown adjacent to the reservations would be increased.

Monitoring and drainage analysis would be necessary to evaluate the case-by-case CBM drainage of adjacent fields. As stated under Alternative B, the timely development of CBM on reservations would reduce the potential for adjacent mineral drainage, but would increase the likelihood of proximity-related impacts to the Absaloka Coal Mine.

The impacts on lands irrigated by streams and rivers receiving untreated CBM discharge would be as described in the *Soils Technical Report* (ALL 2001a), and would be greatly dependent on the altered quality of the particular watershed being used. Increased soil erosion leading to gullying would be a result of development on the reservations along with erosion outside reservation boundaries.

Impacts to air quality, visibility, cultural resources, wildlife, social services, and infrastructure would be the same or similar to those described for Alternative B.

Alternative D—Encourage Exploration and Development While Maintaining Existing Land Uses

The only differences in management objectives for Alternative D that would have an effect on ITAs is the treatment and piped conveyance of production water. This difference would reduce the impacts to erosion along ephemeral drainages, lower the sediment load in watercourses, and limit the water quality impact to both surface water and groundwater. There would be an increase in available surface water for beneficial reuse because of the required treatment and lack of conveyance losses from the piped system of discharge. The lack of conveyance losses would increase the flow in receiving watercourses resulting in course changes and riparian alterations, as identified in Alternative A.

Groundwater drawdown would be as described in Alternative B because of the use of the buffer zone by the BLM. Mineral drainage also would be the same as discussed under Alternative B, with the use of monitoring required to evaluate the case-by-case field conditions. Irrigated lands would be less affected by the use of treated waters, as described in the *Soils* section of this chapter. The Absaloka Coal Mine would experience the same groundwater drawdown impacts as described under Alternative B. Impacts to visibility, cultural resources, wildlife, social services, and infrastructure would be the same or similar to those described for Alternative B on all reservations. Impact to air quality on all reservations would be lower than Alternative B.

Conclusion

Impacts from management decisions included in Alternative D, management practices common to all alternatives, and from projects evaluated under the cumulative effects analysis would result in increased surface water flow, reduction of groundwater availability, and the irreversible loss of fluid minerals.

Impacts on surface water quality would be similar to those discussed under Alternative B with regard to the influence of Wyoming's CBM production waters entering Montana and affecting the Northern Cheyenne water right in the Tongue River Reservoir. With the increase in flow from the treated waters in Montana, the overall SAR values would be adjusted downward, but only slightly. CBM development on reservations would further add to available surface waters once treatment is administered; groundwater drawdown would be the same as discussed in Alternative B. Soil erosion would be decreased because of the use of conveyance systems, which would result in the reduction of suspended solids in watercourses and the elimination of gullying. The impacts on lands irrigated by streams and rivers receiving treated CBM discharge would be reduced. Impacts to air quality, visibility, cultural resources, wildlife, social services, and infrastructure would be the same or similar to those described Alternative B. Impacts to air quality on all reservations would be lower than those discussed under alternative B.

As stated under Alternative B, the timely development of CBM on reservations would reduce the potential for adjacent fluid minerals drainage, but would increase the likelihood of proximity-related impacts to the Absaloka Coal Mine.

Alternative E—Preferred Alternative

The management objectives for Alternative E would result in surface water, groundwater and potential methane drainage impacts similar to those described under Alternative E in the *Hydrology* section. Noteworthy is the fact that the DEQ could set numerical criteria for surface water quality resulting in either restricted discharge to most rivers and streams in the CBM emphasis area or flow based discharge with increased impoundment or discharge with some slight increase to the surface waters SAR, EC, and bicarbonate values. Also noteworthy are the approved Draft Surface Water Quality Standards of the Northern Cheyenne Tribe, which if approved by EPA, could result in restricted discharges in the Tongue River and Rosebud Creek. Regardless of what choice is made, impacts would resemble those described under Alternative E in the *Hydrology* section of this chapter.

There would be no discharge of produced water (treated or untreated) into the watershed unless the operator has an approved National Pollutant Discharge Elimination System (NPDES) permit and can demonstrate in their Water Management Plan how discharge could occur in accordance with water quality laws.

Impacts on groundwater would consist of the same drawdown effects as described in Alternative B, however, implementation of the BLM mitigation measures would reduce the likelihood that reservation water resources would be drained from off-reservation CBM activities.

Water quality impacts from infiltration would be minimized as a result of the design and placement of impoundments. Impoundments proposed as part of the Water Management Plan would be designed and located to minimize or mitigate impacts to soil, water, vegetation, and channel stability reducing infiltration impacts to groundwater quality. In addition, impoundments would likely be required to be permitted under the MDEQ General MPDES permit that includes additional conditions to minimize impacts to groundwater (see Hydrology Appendix).

Impacts on Native American hydrocarbons via adjacent production drainage would be similar to those described for Alternative C. As previously mentioned, site-specific conditions control methane liberation and collection and therefore, to evaluate potential drainage, a case-by-case study is necessary. These studies would be required as part of the APD approval process, along with intensified monitoring to determine when and if Tribal CBM resources would be drained. If drainage is likely, the BLM would require the operator to take appropriate action, in consultation with the Tribes, to reduce or eliminate the drainage, or in the case of a federal well, to compensate the Tribe for the loss.

As discussed earlier under Alternative C, the Absaloka Coal Mine could be encroached on by CBM development but wells could not be drilled within permitted coal mining acres. The coal is held in trust for the Crow Tribe.

As for impacts to air quality, visibility, cultural resources, wildlife, social services, and infrastructure these would be reduced from those described under Alternative B because of the control measures employed with each site-specific Project Plan and the other management features of this alternative discussed in Chapter 2.

Mitigation measures have been developed to protect the Northern Cheyenne Tribal resources, as well as culturally important off-reservation sites. A discussion of these mitigation measures is presented in the Northern Cheyenne Mitigation Appendix. These mitigation and monitoring measures have been designed to provide the BLM and the Tribe with additional information regarding measures that would be used to protect site-specific resources such as groundwater, CBM, air quality, wildlife, vegetation, and cultural resources.

Conclusion

Impacts from management decisions included in Alternative E, have the potential to result in a slight decrease to surface water quality and a minimal reduction in groundwater availability.

Impacts to the Northern Cheyenne's water right in the Tongue River Reservoir would be as described under Alternative A.

Potential impacts on reservation groundwater drawdown and availability would be mitigated by the implementation of specific BLM control measures. Potential impacts to groundwater would be identified early by the intensified monitoring planned under Alternative E.

Monitoring and drainage analysis would be conducted by the BLM to evaluate the potential for CBM drainage. If monitoring indicated Tribal resources were impacted measures such as production decreases or well shut-in would be instituted, and the appropriate Tribal compensation agreement implemented.

The impacts to lands irrigated by streams and rivers receiving CBM discharge would be minimal as only slight alterations in surface water quality are anticipated.

Impacts to air quality, visibility, cultural resources, wildlife, social services, and infrastructure would be reduced from those described under Alternative B because of the mitigation measures employed with each site specific Project Plan and the other management features of this alternative discussed in Chapter 2. Cultural resources, include important off-reservation hunting, fishing, and plant gathering sites.

Impacts to the Northern Cheyenne Reservation resources would be mitigated by the implementation of control measures described by the BLM in the Northern Cheyenne Mitigation Appendix.

Lands and Realty

Lands and Realty	
Emphasis Area Land Ownership: *- Private 65%* *- Federal 20%* *- Tribal 10%* *- State 5%*	*Miles of Road:* *- Interstate, 440* *- US, 845* *- State, 430* *- Off-System, 13,550*
Total Acreage: *25,551,308*	*Miles of Railroad:* *- BNSF, 420* *- MT Rail Link, 190*

Alternative A
No Action (Existing CBM Management)

- Federal:
  - Minimal land area displaced by roads
  - 400 acres disturbed during CBM exploration drilling
- State:
  - Increased motorized access on the CX Ranch.
  - Increase motorized trespass
  - 1,100 acres disturbed during CBM exploration and production activities

Alternative B
CBM Development with Emphasis on Soil, Water, Air, Vegetation, Wildlife and Cultural Resources

- Federal:
  - Increase fire hazard and motorized access.
  - 25,600 acres disturbed during CBM development activities.
- State:
  - Displace agricultural lands.
  - Disrupt irrigation system, increase cost of farm operation.
  - Reduced property values.
  - Displace community and residential growth.
  - Increase dust and noise impacts on residential use.
  - Increase cost of county road maintenance.
  - Increase long-term motorized access.
  - 29,750 acres disturbed during CBM development activities

Alternative C
Emphasize CBM Development

- All impacts in Alternative B occur in Alternative C in addition to:
  - The land use displacement from roads and utility lines during lease operations is greatest in Alternative C
  - 70,000 acres would be disturbed by CBM activities on private, state and federal lands

Alternative D
Encourage CBM Exploration and Development While Maintaining Existing Land Uses

- All impacts in Alternative B occur in Alternative D in addition to:
  - Federal: Permanent loss of land use from road network.

Alternative E
Preferred CBM Development Alternative

- Levels of disturbance would be the same as Alternative B
- Impacts from powerlines, roads, pipelines, and other utilities not requiring transportation corridors would be the same as Alternative C.

Assumptions

Gas from CBM wells is normally measured at the well site or on a collection line before mixing at field compression stations, making it possible for flow lines and compression stations to be shared by different operators to reduce development cost and surface disturbance.

Split estate surface owners have the right to maintain control of non-CBM related access.

Operators are responsible for communicating requirements and stipulations to independent contractors working on behalf of the operator when performing various phases of CBM exploration and production development.

There are no expected disruptions to existing fiber optic, phone, gas, electric, or water lines as a result of the construction, production, or abandonment of project alternatives. It is the responsibility of the operator to identify and avoid buried lines within the pathway of new surface-disturbing activities.

According to the Farmland Protection Policy Act, federal agencies involved in proposed projects that may convert farmland to non-agricultural uses must complete a USDA Farmland Conversion Impact Rating Form AD-1006. The form focuses on two farmland designations: prime farmland and agricultural lands of statewide importance. Prime farmland and agricultural lands designations are based on soil type and productivity and are not based on present use. The AD-1006 form would be completed for each APD application or as part of an Environmental Assessment (EA) checklist to assess impacts to agriculture on federal lands.

No physical displacements of residences or commercial property would result from project alternatives.

CBM-related, human activity increases fire hazards in the project area. The loss of vegetation by fire would impact all land uses including ranching, recreation, and agriculture, and would limit access to public lands because reclamation would be sensitive to soil disturbance.

The required reclamation plan by the operator would be reviewed and approved by BLM on federal lands, by the state on state lands, and by the landowner on private lands.

Impacts From Management Common to All Alternatives

Potential land use impacts would primarily consist of conflicts between conventional oil and gas activities and other uses of property, such as agriculture, residences, and coal mines. New authorizations for major gathering lines, major transportation lines, and power lines, for example, would impact rights-of-way (ROWs) and land segmenting. The development of oil and gas resources impacts agricultural production by taking land out of production and by soil contamination from drilling and production activities.

Surface disturbance associated with oil and gas activities, such as roads, well pads, and battery sites would remove those areas of agricultural production during the life of the road, well pad, or tank battery site. Removal of vegetation would reduce the acreage available for livestock grazing or crop production. Buried flowline and utility line routes would be seeded so the acreage would be temporarily removed from use for grazing or crop production. The infrastructure associated with oil and gas production could affect the movement or area available for livestock and could hinder irrigation systems.

Most existing roads would be lightly traveled by local residents, ranchers, and oil and gas workers. Use of unimproved roads would increase because of daily operations for a month at each site during development and testing of exploration wells. This road activity would be increased in general areas targeted for well development. Unimproved roads would be vulnerable to damage in adverse weather conditions. Public and private lands could be impacted by driving on soft or unstable road surfaces.

Residents and public visitors would be impacted by the sights, sounds, and delays caused by the construction and testing of exploratory and production wells. An increase in slow-moving vehicles would be an impact in areas not currently experiencing these activities. Creation of a temporary, unimproved, unrestricted access road to an area would allow public access and exposure of the property in a new way, and would expand the road system requiring maintenance by federal or state agencies and private landowners.

Public access to most wells would likely be limited because 65 percent of the land area is private; however, there would be conflicts with recreation (see the *Recreation* section of this chapter). Short-term impacts would occur during road building, pad development, drilling, and production-related activities. Access for recreation on legally accessible public lands would increase as a result of the increase in unimproved roads. These impacts would be viewed as a benefit to sportsmen, who generally support increased vehicle access. Road densities on private lands would likely increase in the areas targeted for oil and gas wells, but property owners would be responsible for access control.

CBM development would increase the likelihood of fire because there would be potential incendiary activities occurring where none now occur. Specific causes may include methane leaks, electrical fires from drilling and other construction activities, fires from ruptured gas pipelines, careless smokers, gas migrating from domestic wells contaminated with methane gas, and hot catalytic converters on vehicles.

Produced water of quality suitable for livestock could be placed in impoundments in areas currently without such impoundments for livestock. This would enhance or expand livestock grazing. Construction disturbance would also force cattle onto previously unused range, further changing land use (see discussion on Livestock Grazing). Similar displacement would occur for wildlife, disrupting hunting on land designated for controlled or general hunts.

There may be a trespass impact to private landowners from the conversion of unroaded federal lands with a right-of-way that now allows access to private lands.

On private and public lands, road maintenance would be specified in the lease agreement, drilling permit or Right of Way as the responsibility of either the contractor or landowner.

Complete removal of the indication of vehicle passage and revegetation of two-track exploration on public lands would be important to prevent these temporary roads from becoming an established access through consistent misuse by four-wheel-drive and all-terrain vehicles, especially in areas historically not accessed by vehicles. The Vegetation section describes the seeding policy for reclaiming surface disturbances.

Impacts From Management Specific To Each Alternative

Alternative A—No Action (Existing CBM Management)

Impacts on multiple use of public lands would be minimal because there would be no CBM production development on federal lands. State and private lands would have limited CBM production activities.

Exploration

The amount of new roads to be built would be minimal relative to other alternatives. The primary land use impacts on federal and state lands are from short-term direct land use displacement by exploratory well pads and the creation of two-track trails across prairie or other lands from exploratory equipment. Impacts on private lands would be largely addressed in the contractual agreement with the private owners of the CX ranch.

Production

Newly created roads for CBM production would increase access across the CX Ranch that may displace or change the land use patterns on the land.

Abandonment

Two-track trails and associated motorized access created by CBM exploration on federal and state lands would be reclaimed after abandonment, unless otherwise authorized. New access created under a ROW may be reclaimed depending on the situation and the BLM and surface owner's requirements. New motorized access in watersheds targeted for water quality restoration by MDEQ may require road reclamation as part of abandonment. Reclamation based on water quality would be on a case-by-case basis with involvement from MDEQ. Abandonment and reclamation of roads on the CX Ranch could be highly variable according to the agreement with the surface owner. Abandonment impacts on private land cannot be determined because of its variability, but private landowners would be able to negotiate reclamation agreements to avoid long-term impacts to their land. Unwanted roads on the CX Ranch would be obliterated and revegetated according to the agreement with the lease operator.

Crow Reservation

Impacts on the Crow Reservation would be the same as described in general for Alternative A. If there were no CBM development on Tribal Lands, then there are expected to be minimal, if any, impacts to the reservation. Trespassing from CBM related vehicles might increase because of activities adjacent to the reservation. Traffic is also expected to increase on reservation roads.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation. Traffic is also expected to increase on reservation roads.

Conclusion

Alternative A would have the least land use impact among alternatives because of the limited number of exploration and production wells within the project area. The greatest potential land use impact would be the ranching disturbance and displacement on the CX Ranch (see the *Livestock Grazing* section of this chapter). Approximately 500 acres of surface area would be disturbed, which is less than 0.01 percent of the total RMP areas and Park, Blaine, and Gallatin Counties.

Cumulative impacts are estimated to be approximately 37,470 acres of disturbance. In addition to CBM related activities, includes impacts associated with conventional oil and gas, active coal mines, fires, highway projects, and power plants. The cumulative impacts comprise 0.15 percent of the entire emphasis area.

Alternative B—Emphasize Soil, Water, Air, Vegetation, Wildlife, and Cultural Resources

Exploration And Production

Short-term impacts of land uses during construction would consist of the physical intrusion by CBM crews and equipment, the local generation of dust and noise, and the limited obstruction of traffic. Long-term impacts include loss of existing land use, increased access from roads, and loss of land value.

Some surface landowners are unaware of the severed mineral rights, and even though compensated, would be displeased with the possibility of having well facilities located near dwellings. There are no legally

required buffer distances between CBM facilities and residential, community, or government dwellings. Placement of roads and well pads near residential, business, and community dwellings may cause direct reduction of property values.

Although there may be no statute that covers buffer distances, State of Montana oil and gas leases include a minimum buffer distance of 200 feet. Reasonable additional buffers can be added as needed at the time of site-specific operating plan review, including movement up to 656 feet on Federal leases.

Impacts from placement of roads, utility lines, pipelines, and well pads around communities may cause loss of future community development opportunities. These uses displace other surface uses like residential development and location of public parks and schools. There are safety and liability concerns.

Although private landowners and state land managing agencies would help decide road routes on their lands, as described in the Mitigation section, they would likely want to maintain some roads that benefit existing or future uses.

The increase in average daily traffic (ADT) of U.S., interstate, and state highways by action alternatives would be minor and is not expected to decrease their designed level of service within the CBM project area. Increased highway ADT over the 20-year life of the project would be largely from increases in demographics.

County roads in some portions of the project area would receive substantial CBM exploration and development traffic volumes. This large influx of CBM-related traffic on some isolated county and local roads would increase their associated road maintenance cost.

Lease operators would discuss compensation with county and local road and bridge departments when CBM-related traffic has caused increased road maintenance cost. There may be times when an operator or a group of operators may choose to provide maintenance for a particular road.

Short-term exploration impacts to farming include seasonal loss of crops during construction, interference with irrigation patterns, and increased introduction of noxious weeds.

Cropland area converted to production well pads and roads would be lost for the up to 20-year life of the project. Based on estimates in the Vegetation section, 20 percent of wells on state-permitted land in Blaine, Gallatin, and Park counties would occur in cropland soils. Four percent of wells in the Powder River RMP area and 8 percent of the wells in the Billings RMP area would occur in cropland soils. Specific long-term impacts include land displacement; alteration of existing flood and center pivot irrigation systems; modification of farming operations near and around well pads and access roads; potential for proliferation of noxious weeds; surface and groundwater quality losses; farming operations that are no longer commercially viable at certain locations; economic losses associated with all of the above; and lower land values.

Direct impacts on commercial woodlands would be caused by the immediate harvest of timber in ROWs and well pad sites and the loss of timber growth in these areas during the life of production and time of regrowth to merchantable trees. The income loss for the tree growth loss is reflective of time to grow merchantable trees, which is 50 to 100 years after reclamation of ROWs and pad sites. New roads on public forest lands may become part of the existing road system and their ROWs would be a permanent loss of timber production. The increased use of four-wheel-drive and all-terrain vehicles would allow other vehicles to have extensive access once a route is established.

Roads from CBM development and CBM-related motorized activity may create conflict with timber cruising, logging, and hauling activities of an active timber sale. CBM-related traffic could increase traffic hazards with log-hauling trucks unless road use coordination occurs.

Indirect impacts from land clearing include wood fuel loading, introduction of noxious weeds; increases in insect population from slash buildup; and increased access for forest and fire management. CBM-constructed roads may not always be located in the best area for managing forest resources.

Abandonment

On federal and state lands, the access plan would create fewer two-track trails and roads than other development alternatives. Utility reclamation would occur with road reclamation because they are located in the same corridor. Public access would be restricted over the life of the CBM productions on the road network, and would not become part of the permanent public access network. On private lands, road abandonment would be highly variable because each landowner agreement could be different.

Regeneration time of timber to commercial size after CBM activities or other related land use would likely be 50 to 100 years. Road obliteration would include re-contouring the landscape and planting tree seedlings appropriate to the forest site.

Damage from a fire related to CBM activities would be the responsibility of the operator. Liability of fire is detailed in Statute 50-63-103 Montana Code Annotated (MCA).

Crow Reservation

If there were no CBM development on Tribal Lands, then impacts on the reservation, other than CBM related traffic discussed above, would be minimal.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under Alternative B.

Conclusion

Alternative B would have the least impact to present land use of the four development alternatives (B, C, D, and E). For example, the required use of a transportation corridor for both road and utility lines in a one-way pattern reduces the direct surface disturbance by an estimated one-third compared to a grid pattern, multiple corridor approach.

Common land use impacts from roads, pads, pipelines, and utility lines include direct loss of agriculture, timber, grazing, recreation, and wildlife habitat and increased potential of wildfire. Indirect impacts include limited road access; dust, noise, and reduced property values; and increased local road maintenance cost, production, water storage, and ground injection, which reduces the potential direct and indirect impacts to other surface land uses. Residual benefits of the road networks created for CBM development include increased access for fighting fires and create fuel breaks.

Most direct and indirect impacts are mitigated through reclamation and financial compensation. Although minimal impacts due to dust may occur dust abatement measures would be actively employed to minimize impacts to air quality as well as land resources. Surface owner agreements would be used to prevent avoidable impacts to residents and communities. Impacts minimized by surface owner agreements include but are not limited to disruption to irrigation facilities, placement of roads, pipelines, and well pads. Unmitigated impacts include displaced, non-monetary uses like public access, fire hazards, and noise disturbance to livestock Alternative B is estimated to cause 32,940 acres of surface disturbance, which is less than one percent of the total RMP areas and Park, Blaine, and Gallatin Counties.

Cumulative impacts for Alternative B include increased fire hazards from CBM exploration and development, which are the largest potential cumulative economic and environmental impacts to future land uses. The loss of range, timber, habitat, dwellings, access, and other impacts would not be recovered for a long time. However cumulative impacts are estimated to be 84,670 acres which is less than 1 percent of the entire emphasis area.

Alternative C—Emphasize CBM Development

The less stringent access plan, separate placement of pipelines, utility lines, lack of buffers, and use of production water, would lead to an increase in surface land disturbance when compared to the other alternatives.

Exploration And Production

New production roads may be placed along existing trails or be placed in the more traditional road grid system, which allows multiple routes from any production intersection. The traditional road grid system used for CBM production would create the highest density of roads and may increase the size of the public road network. On private lands, road placement would be a contractual agreement with the surface owner and roads may be left in place or reclaimed.

Surface disturbance from roads, pipelines, and utility lines is estimated to be approximately 30 percent greater than Alternatives B and D (see Table 2-2 in Chapter 2) because there are not the same road and utility restrictions to this alternative. Surface disturbance and its impact to agriculture is similar to Alternative B because most agriculture is on private lands. The potential impacts from production water discharges are also similar for the same reason.

CBM production water may have high levels of salinity or sodicity, which can cause negative impacts to agriculture with continued use. The saline level of the average CBM production water is near the threshold for causing yield reduction. Reduction in yields would be expected in salinity-sensitive crops like alfalfa, corn, and clover hay. High SAR production water would reduce water infiltration, especially in clay soils, and would increase erosion.

CBM water with combined high SAR and low EC can cause notable reductions in the water infiltration rate of irrigated crops (ALL 2001b). Repeated sprinkler-applied CBM water high in saline can cause salt accumulation near the soil surface and cause foliar damage to certain crops. Dewatering coal seams may lead to release of methane gas that can contaminate neighboring agricultural and residential wells (ALL 2001b). The contamination of wells is a possibility that cannot be estimated in either amount of methane per well or by proximity of a well to a CBM field. Any contaminated well could be rendered unusable, and if the well is within a closed structure, increased ventilation is required to reduce buildup to explosive quantities.

It must be assumed that the historic road grid system used for CBM development is a worst-case scenario allowed under this alternative when there are no existing disturbances. The road grid system would create the densest road network and largest surface disturbance by providing multiple access to all the wells in the 80-acre well spacing proposal.

Abandonment

Land use displacement from road disturbances would be an assumed 20-year loss on federal, state, and private lands as in Alternative B, except there is more displacement on federal and state lands with this alternative. Land use displacement on private lands would have varying degrees of reclamation based on whether road placements benefit long-term private operations.

There is limited access to many small federal land parcels within the project area. CBM lease operators would create roads to these parcels and increase access and potential public use of the federal parcels. Neighboring private owners who have contributed access to the federal and state parcels may incur increased trespass problems similar to Alternatives B and D.

Crow Reservation

If there were no CBM development on Tribal Lands, then impacts on the reservation, other than increased CBM related trespass problems discussed above, would be minimal.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under Alternative C.

Conclusion

CBM management under Alternative C would result in the most impacts to present land uses among the four development alternatives (B, C, D and E). The disturbance is estimated to be one-third greater than Alternatives B and D. The two main causes for the increased surface disturbance and land use displacement are from use of a traditional road grid system. Surface owner agreements would be used to minimize surface disturbance due to road placement.

Overall approximately 47,598 acres of surface on private lands would be impacted, even with the increased impacts this area is less than one percent of the RMP areas and Park, Blaine, and Gallatin Counties. Cumulative impacts including the additional surface impacts total 105,897 acres for Alternative C. The increased cumulative impacts remain below 1 percent of the entire emphasis area.

Alternative D—Encourage Exploration and Development While Maintaining Existing Land Uses

Short-term transportation impacts on federal and state land uses would be the same as Alternative B. However, the long-term transportation impacts would be greatest because road obliteration and reclamation might not occur under this alternative and would permanently displace present and future land uses. The roads would become part of the public transportation system and would increase vehicle access on federal lands. The existing public road network may receive substantial traffic during production, requiring increased maintenance cost by public agencies. The new roads on federal lands that are not reclaimed would become the maintenance responsibility of the corresponding public agency.

Crow Reservation

Impacts on the Crow Reservation would be primarily the result of vehicle trespassing.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under Alternative D.

Conclusion

Alternative D has the same short-term transportation impacts as Alternative B but has the greatest long-term land use displacement impacts from the created

permanent roads. The types of land use displacement with this alternative are the same as other development alternatives. Surface owner agreements would be used to minimize impacts due to land use displacement.

Most direct and indirect impacts are mitigated through reclamation and financial compensation. Unmitigated impacts include public access, fire hazards, and disturbance to livestock. Total permanent surface impacts and cumulative impacts are estimated to be the same as alternative B.

Alternative E—Preferred Alternative

Exploration and Production

The type of impacts from roads, pipelines, and utility lines in Alternative E are the same as those described in Alternative B. The extent of these impacts would be the same as described in Alternative C. This alternative, like Alternative C, would not require transportation corridors for the placement of roads, utility lines, and pipelines. Existing disturbances would be used as much as possible for utility access. Management features of Alternative E include burying power lines in certain locations and requirements of a project plan to minimize impacts.

Land use displacement from road disturbances would be up to 20-years on federal, state, and private lands as with Alternatives B and C. CBM lease operators would create roads to small federal and state parcels never before road accessible to the public. Motorized trespass would be enhanced as a result of the increased road network on federal, state, and private lands from CBM-related exploration and development.

Agricultural-related impacts would be the same as those described in Alternative B.

CBM activities increases the likelihood of fire. Road networks created for CBM development would increase access for fighting fires.

Abandonment

Abandonment of roads, utility lines, and powerlines would be the same as described in Alternative C.

On private lands, road abandonment would be highly variable as with the other alternatives because each landowner agreement would be different.

Liability of fire is detailed in Statute 50-63-103 Montana Code Annotated.

Conclusion

CBM operators would be required to submit a Project Plan when the proposed development for an area would exceed one well per 640 acres.

The type of impacts from roads, pipeline, and utility line in Alternative E are the same as those described in Alternative B. The extent of impacts would be the same as described in Alternative C. This alternative, like Alternative C, would not require transportation corridors for the placement or roads, utility lines, and pipelines. Existing disturbances would be used as much as possible.

New roads would remain open or closed at the surface owner's discretion. Roads would be reclaimed upon abandonment.

There would be no degradation of watersheds from release of production water. A Water Management Plan would be required for every exploration Permit to Drill. First priority for discharged water would be for beneficial uses.

The potential for fire hazard is the same as Alternatives B, C, and D. Surface disturbances associated with Alternative E would impact approximately 44,040 acres. This is equivalent to less than one percent of the combined area of the RMP areas and of Park, Blaine, and Gallatin Counties. The total area of cumulative impacts, including surface disturbances from additional activities described previously, are estimated to be 95,770 acres. This total area is less than 1 percent of the entire emphasis area.

Livestock Grazing

Livestock Grazing *AUM is equal to the amount of forage required to support one cow and her calf or 5 sheep for one month.* *The CBM Emphasis area has an estimated 1,207,400 acres of classified grazing and forested lands capable of supporting 323,941 AUMs.*
Alternative A **No Action (Existing CBM Management)**
• Exploration wells located within BLM-permitted rangelands would result in the temporary loss of 69 AUMs • State: – The exploration wells and production wells located at CX Ranch would result in a maximum construction loss of 272 AUMs on state and private rangelands.
Alternative B **CBM Development with Emphasis on Soil, Water, Air, Vegetation, Wildlife and Cultural Resources**
• Exploration wells would result in the temporary loss of 413 AUMs (BLM 163, State 250). • Production wells would result in a maximum construction loss of 11,960 AUMs (BLM 4,770, State 7,190).
Alternative C **Emphasize CBM Development**
• Impacts to livestock grazing would be similar to but slightly greater than those in Alternative B due to the discharge of untreated production water on to the ground resulting in increased erosion • CBM discharge water could be used for livestock watering. • Increased erosion could result in increased surface disturbance, which could lead to disrupted grazing patterns, undermined fencing, and reduced forage. • A decrease in forage could occur if discharged produced water is too high in saline content; and possible effects to livestock if produced water is to unsuitable quality for stock watering.
Alternative D **Encourage CBM Exploration and Development While Maintaining Existing Land Uses**
• Impacts would be similar to Alternative B with some exceptions: disturbed acreage would increase due to the piping of discharge water to the nearest disposal point. There would be less forage losses than A.H.B.
Alternative E **Preferred CBM Development Alternative**
• Impacts to livestock grazing would be similar to Alternative B. • Suitable CBM discharge water could be used for livestock watering. • Land application of produced water would promote growth of vegetation.

Livestock grazing and petroleum development would be generally compatible because exploration activity would be temporary and operational activities require a small area for equipment. Livestock grazing on rangeland would continue during CBM and conventional oil and gas development.

Assumptions

Affected acres and animal unit months (AUMs) were calculated assuming all CBM activity would be located on grazing lands. AUM losses were predicted separately for the two BLM RMPs and the state because of differences in permits and land grazing capacities. The analysis is focused on the CBM emphasis area, but applies to similar areas throughout Montana. It is assumed that existing roads and fence crossings would be used for oil and gas operations as much as possible.

Impacts From Management Common to All Alternatives

Impacts on rangeland would occur from the loss of vegetation for livestock grazing; the disruption to livestock management practices; and loss of grazing capacity from construction of well pads and roads. Each well would present its own set of unique circumstances that would be mitigated to minimize impacts. With the exception of minimal short-term forage loss, these impacts would only last as long as construction activities were ongoing. Controlling livestock movement by maintaining fence line integrity would be used to preserve efficient livestock and range management. The construction of roads and pipelines would bisect fences, which would require placement and maintenance of cattle guards and gates. The current development of oil and gas and CBM on state land would require installation of cattle guards on fence lines to prevent livestock escape. The impacts of oil and gas development would result in the loss of about 833 AUMs in the Billings RMP, 830 AUMs in the Powder River RMP, and 359 AUMs on state-permitted rangelands. These losses would be reduced to a total of 735 AUMs during the production phase of oil and gas activities.

While roads, trails, and well pads would block traditional cattle trails, this network of new roads would provide livestock producers with improved access to remote livestock facilities and grazing areas. However, road systems would interfere with livestock dispersal and cause decreased forage efficiency because cattle tend to congregate and travel along roads. The relatively high volumes of exploration vehicle traffic would present a hazard to livestock.

Heavy traffic on temporary access roads would increase the risk of collision with stock, resulting in injury or death of the animals. Airborne dust stirred up by heavy exploration vehicles would settle on forage along the road. The dust would affect the palatability of grass and forbs up to 1/4 mile from the road. Livestock forage could be killed by accidental spills of crude oil, high saline-produced water, or drilling fluid.

Areas of soil disturbance, such as results from construction, may experience an influx of noxious weeds. Noxious weeds reduce rangeland value to livestock by displacing preferred forage species. Severe infestations would result if weeds are not controlled, decreasing rangeland capacity for grazing. Additionally, some weed species are poisonous to livestock, causing illness, internal injury, or death when ingested.

Impacts From Management Specific to Each Alternative

Alternative A—No Action (Existing CBM Management)

Exploration wells located on BLM-permitted rangelands would result in the temporary loss of 30 AUMs for the Billings RMP rangeland and 39 AUMs for the Powder River RMP rangeland. There would be no production activities in BLM planning areas under this alternative and, therefore, no impacts from production. State-permitted exploration and production wells located at CX Ranch would result in a loss of 272 AUMs. Revegetating parts of the well pads during production would reduce the losses to 194 AUMs.

Crow Reservation

Impacts on the Crow Reservation would be the same as described in general for Alternative A. If there were no CBM development on Tribal Lands, then there are expected to be minimal, if any, impacts on livestock grazing on the reservation. If there is CBM development on the reservation, then reductions in AUMs could be occur.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation.

Conclusion

During the next 20 years, disturbances from CBM development, conventional oil and gas development, and other projects considered under the cumulative effects analysis would result in the loss of about 863 AUMs in the Billings RMP, 869 AUMs in the Powder River RMP, and 955 AUMs on state-permitted and private rangelands. These losses would be reduced to a total of 929 AUMs during the production phase of CBM and conventional oil and gas activities. After CBM production ceases, the lands would be reclaimed. Revegetated areas would be available for livestock grazing.

Alternative B—Emphasize Soil, Water, Air, Vegetation, Wildlife, and Cultural Resources

Alternative B considers expanded development of CBM resources. Table 4-47 presents the predicted AUMs that would be lost from exploration, construction, and production on both BLM and state grazing lands. Losses from exploration would be mostly temporary (less than 5 years) and would be reclaimed after exploration activities cease. Revegetating parts of the well pads during production would be used to reduce construction losses to those shown below under operation losses.

Impacts on livestock grazing would be reduced under this alternative through the requirement of transportation corridors, using multiple completions per well bore and directional drilling, injecting produced water instead of storing on-site in impoundments, and rehabilitating new roads at the end of the well lifetime. All of these would help to minimize the area of surface disturbances shown in Table 4-47 by up to 35 percent during construction and 40 percent during production, thus reducing the number of AUMs lost.

Crow Reservation

If there were no CBM development on Tribal Lands, then there are expected to be minimal, if any, impacts on livestock grazing on the reservation. If there is CBM development on the reservation, then reductions in AUMs would occur.

TABLE 4-47
NUMBER OF PREDICTED ANIMAL UNIT MONTHS (AUMS) LOST TO EXPLORATION, CONSTRUCTION, AND PRODUCTION

	AUMs Lost to Exploration	AUMs Lost to Construction	AUMs Lost to Operation
Billings RMP	11	340	209
Powder River RMP	152	4,430	2,275
BLM Sub-total	163	4,770	2,484
State/Private Lands	250	7,190	4,420
Total	**413**	**11,960**	**6,904**

Northern Cheyenne Reservation

If there were no CBM development on Tribal Lands, then there are expected to be minimal, if any, impacts on livestock grazing on the reservation. If there is CBM development on the reservation, then reductions in AUMs would occur.

Conclusion

During the next 20 years, disturbances from CBM development on state, BLM, Native American, and USFS lands; along with the cumulative effects of other projects would result in the loss of about 18,500 AUMs. These AUM losses would be partially recovered during the production phase of CBM and oil and gas activities, and after production ceases and the lands are reclaimed. The requirement for transportation corridors, injection of produced water (less land needed for impoundments), and multiple use of drilling pads would help to minimize livestock grazing losses up to 35 or 40 percent.

Alternative C—Emphasize CBM Development

Impacts on livestock grazing would be similar to Alternative B with the following exceptions: transportation corridors and collocation of wells would not be required, thereby increasing the number of disturbed acres and AUMs lost compared to Alternative B (see Table 4-47); suitable CBM discharge water could be used for livestock watering reducing the amount discharged; and the discharge of produced water to the surface would increase erosion and cause increased surface disturbance to livestock. Other impacts would include the possibility of an increase of noxious weeds and a decrease in forage material if produced water that is too high in saline content is discharged on the land surface, and possible health effects if livestock consume produced water that is unacceptable (ALL 2001b). Generally, water is acceptable for livestock if the TDS is lower than 10,000 mg/l and the EC is less than 16,000 µS/cm. Some CBM water has also been found to exceed standards for fluoride (2 mg/l) and aluminum (0.2 mg/l) (ALL 2001b). Discharging untreated CBM-produced water on the ground surface at the well pad would lead to increased localized soil erosion and gullying, which could also lead to disrupted grazing patterns, undermined fencing, and reduced forage.

Crow Reservation

Off-reservation development will not affect on-Reservation livestock grazing practices. The discharge of untreated CBM production water on ground surfaces within the reservation boundary (from development adjacent to the reservation) could lead to localized soil erosion, which could result in the creation of gullies, fence post disturbance, and limited vegetation loss.

Northern Cheyenne Reservation

Off-reservation development will not affect on-Reservation livestock grazing practices. The discharge of untreated CBM production water on ground surfaces within the reservation boundary (from development adjacent to the reservation) could lead to localized soil erosion, which could result in the creation of gullies, fence post disturbance, and limited vegetation loss.

Conclusion

Cumulative impacts would be similar to Alternative B with some exceptions. The surface disturbance could be greater since transportation corridors and collocated wells are not required. Surface discharge of untreated

produced water could result in increased forage loss, erosion, gullying, grazing pattern disruptions, and fencing undermining. Forage losses could be permanent because of soil sterilization by saline water applications. This amount would vary depending on the quality and quantity of water discharged. Watering livestock represents only a small portion of the estimated 20 percent beneficial reuse assumed under this alternative, but would still result in a small amount of impacts reduction to the other resources.

Alternative D—Encourage Exploration and Development While Maintaining Existing Land Uses

Impacts on livestock grazing would be similar to Alternative C with the following exceptions: impacts from drilling and collocation of wells would be the same as Alternative B; transportation corridor and road impacts would be similar to Alternative B; discharged CBM-produced water would be treated and not discharged directly at the well site; and there would be a reduction to forage losses from increased land application of produced water through irrigation applications. This would be a favorable impact from having more treated water available in the winter and arid months available for livestock watering and irrigation of grazing lands. Mitigation measures would be similar to Alternative B.

Crow Reservation

Off-reservation development will not affect on-Reservation livestock grazing practices.

Northern Cheyenne Reservation

Off-reservation development will not affect on-Reservation livestock grazing practices.

Conclusion

Cumulative impacts would be similar to Alternative C with some exceptions: impacts from drilling and co-location of wells would be the same as Alternative B; transportation corridor and road impacts would be

similar to Alternative B; there would be a reduction to forage losses from increased land application of produced water; and there would be less soil and forage loss from erosion of soils.

Alternative E—Preferred Alternative

Impacts on livestock grazing would be similar to Alternative B with the following exceptions: transportation corridors and co-location of wells would not be required, thereby increasing the number of disturbed acres and AUMs lost compared to Alternative B (see Table 4-47); suitable CBM discharge water could be used for livestock watering reducing the amount discharged; Water Management Plans would be designed on a site-specific basis so no degradation would occur to water quality or to beneficial use. Such uses could include livestock watering and irrigation (benefits for livestock). Mitigation measures would be similar to Alternative B.

Crow Reservation

Off-reservation development will not affect on-Reservation livestock grazing practices.

Northern Cheyenne Reservation

Off-reservation development will not affect on-Reservation livestock grazing practices.

Conclusion

Cumulative impacts would be similar to Alternative B with some exceptions. The surface disturbance could be greater since transportation corridors and co-located wells are not required. There would be less soil and forage loss from erosion of soils. Beneficial use of produced water by watering livestock would reduce, by a small amount, the impacts to other resources.

Paleontological Resources

Paleontological Resources *Paleontological resources consist of fossil-bearing rock formations that underlie the entire planning area. Fossil outcrops are relatively rare throughout the emphasis area, but know areas are protected.*
Alternative A **No Action (Existing CBM Management)**
• It is unlikely that any of the 1,500 acres disturbed during CBM development activities would contain noteworthy paleontological resources. The 575-acre Bridger Fossil Area ACEC (only paleontological resource) would not be disturbed.
Alternatives B, C, D, and E
• Impacts would be nearly the same based on level of disturbance, know locations of rich fossil areas and distription of geological formations with paleontological resources. • There would be between 55,400 and 74,000 short term acres disturbed during CBM development activities increasing the chances that a minor fossil discovery would be made. Cumulative impacts would disturb an additional 33,400 acres increasing the likelihood of additional fossil discoveries.

Assumptions

Surface occupancy is prohibited within designated paleontological sites on BLM minerals in the planning area. A modification or waiver may be applied for as mentioned for the Cultural Resource section. Provided the paleontological resource values can be protected or undesirable impacts mitigated, the exception would be granted.

Impacts From Management Common to All Alternatives

Impacts would occur if paleontological resources were encountered unexpectedly during surface disturbance activities.

Impacts From Management Specific to Each Alternative

Alternative A—No Action (Existing CBM Management)

Impacts from this alternative would be similar to those described in the *Impacts From Management Common to All Alternatives* section above, with some exceptions. In CBM development there would be no geophysical exploration that could result in the destruction of paleontological resources. Other impacts would include vandalism and removal of fossils by fossil collectors resulting from increased accessibility to remote areas.

Crow Reservation

There would not be impacts to paleontological resources on the Crow Reservation from off-reservation CBM development.

Northern Cheyenne Reservation

There would not be impacts to paleontological resources on the Northern Cheyenne Reservation from off-reservation CBM development.

Conclusion

Cumulative impacts would include the effects from CBM development, conventional oil and gas development, and surface coal mining activities. Known paleontological resources within the planning area would be protected by Section 6 of the lease terms. NSO stipulations applied to known paleontological resources would help protect those sites.

Alternative B—Emphasize Soil, Water, Air, Vegetation, Wildlife, and Cultural Resources

Impacts from Alternative B would be similar to Alternative A, with some exceptions. Development could result in increased access to remote areas. The impacts of increased access could include vandalism or removal of fossils by fossil hunters.

Crow Reservation

There are no anticipated impacts to paleontological resources on the Crow Reservation from off-reservation CBM development.

Northern Cheyenne Reservation

There are no anticipated impacts to paleontological resources on the Northern Cheyenne Reservation from off-reservation CBM development.

Conclusion

Cumulative impacts under this alternative would include increased CBM development and a potential increase in vandalism or removal of fossils.

With the development of Tribal CBM resources, it is anticipated that some reservation sites would be

encountered that may contain important paleontological resources. As the Tribes develop their own CBM resources, it is anticipated that Tribal monitors would oversee all surface disturbing activities and, therefore, all significant paleontological resources would be protected.

Alternative C—Emphasize CBM Development

Impacts would be similar to Alternative B with some exceptions. Under this alternative, surface disturbances from ROWs would result in impacts on paleontological resources and increased access to remote areas. The impacts of increased access could include increased vandalism and removal of fossils by fossil hunters.

Crow Reservation

There are no anticipated impacts to paleontological resources on the Crow Reservation from off-reservation CBM development.

Northern Cheyenne Reservation

There are no anticipated impacts to paleontological resources on the Northern Cheyenne Reservation from off-reservation CBM development.

Conclusion

Cumulative impacts would be similar to Alternative B with increased surface disturbance from the lack of ROWs, potential vandalism or removal of fossils because of increased access to remote areas.

The use of Tribal monitors overseeing surface disturbing activities on the reservations during Tribal CBM development would prevent most impacts from occurring to paleontological resources.

Alternative D—Encourage Exploration and Development While Maintaining Existing Land Uses

Impacts would be the same as described under Alternative B.

Alternative E—Preferred Alternative

Impacts would be similar to Alternative C with some exceptions. Under this alternative, the project plan stipulations could decrease the amount of surface disturbance. Directional drilling may be performed on deeper coal seams and would decrease surface disturbances. The potential for impacts from surface disturbances resulting from the placement of underground utilities would increase impacts to paleontological resources. Where significant paleontological resources are suspected, the operator's plan will include a paleontological component that will address data collection and evaluation methods if paleontological remains are encountered.

Crow Reservation

There are no anticipated impacts to paleontological resources on the Crow Reservation from off-reservation CBM development.

Northern Cheyenne Reservation

There are no anticipated impacts to paleontological resources on the Northern Cheyenne Reservation from off-reservation CBM development.

Conclusion

Cumulative impacts under this alternative would be similar to Alternative C with the exception of the potential for less surface disturbances The impacts to paleontological resources would be minimized.

The use of Tribal monitors overseeing all land disturbing activities on the reservations during Tribal CBM development would prevent most impacts from occurring to paleontological resources.

Recreation

Recreation *Montana's natural features offer a variety of year-round recreational opportunities*
Alternative A **No Action (Existing CBM Management)**
• Minor loss of land for recreation purposes, and the disruption to recreation activities • Exploratory activities such as drilling and testing could temporarily displace game species locally
Alternative B **CBM Development with Emphasis on Soil, Water, Air, Vegetation, Wildlife and Cultural Resources**
• Moderate loss of land for recreation purposes and the disruption to recreational activities • Increased opportunities for access to remote areas
Alternative C **Emphasize CBM Development**
• Impacts would be similar to Alternative B with the exception that increased erosion could lead to a reduced amount of land available for recreation activities and could disrupt habitat for game species.
Alternative D **Encourage CBM Exploration and Development While Maintaining Existing Land Uses**
• Impacts would be similar to Alternative B.
Alternative E **Preferred CBM Development Alternative**
• Impacts would be similar to Alternative B.

Assumptions

Recreation uses and areas are described in Chapter 3. Most of the recreation resources in the study area consist of dispersed activities such as hunting and fishing. BLM stipulations would be applied. Surface disturbance assumptions are detailed in the *Analysis Assumptions and Guidelines* section of this chapter. In general, the demand for recreational activities would increase proportionately with the increase or decline of regional populations.

Impacts From Management Common to All Alternatives

Recreation areas are potentially impacted by surface-disturbing activities. The activities that involve the use of heavy equipment (road construction, well drilling, pad construction, pipeline and utility placement, etc.) would result in changes to the natural landscape, which would cause the most surface disturbance and have the greatest impact on recreation areas. Other activities, such as increased travel and vandalism resulting from access improvements, and increased erosion from surface disturbances, can also impact recreation areas. These activities can produce indirect impacts to recreation areas such as fires, hazardous waste spills and cleanups, changes in livestock grazing patterns, and changes in wildlife habitats.

BLM has stipulations to protect developed recreation areas and undeveloped recreation areas receiving concentrated public use The state also has stipulations for protection of recreation areas including prohibiting activity within 100 feet of streams, ponds, lakes, or other water facilities. Additional state stipulations include a 1/8-mile buffer for rivers, lakes, or reservoirs, and a sensitive areas stipulation that may be used when field staff receive comments regarding recreation areas. Most of the recreation resources in the study area are dispersed activities, such as hunting and fishing, and are not developed recreation sites. Exploratory activities such as drilling and testing would temporarily displace game species locally. Installation of oil and gas production facilities in areas used for hunting, hiking, and other dispersed recreational activities would infringe on the solitude and rural characteristics of the area. The oil and gas infrastructure and activities would reduce the number of game animals in the area or force some game animals to leave the area which would reduce or eliminate certain hunting activities. Hunters would be concerned about shooting around facilities and equipment.

Exploration and production would create new roads that would provide easier motorized access to areas that may not have been accessible before. Motorized recreation user groups would see this as a benefit to their sports, and would appreciate increased access to streams, lakes, and hunting areas. Non-motorized recreational enthusiasts who seek solitude and quiet, including backpackers, hikers, and some hunters and anglers, would not benefit from road development. As formerly remote areas become more accessible and competition for limited resource escalates, conflicts among these user groups would occur.

Increased human access and increased human activity associated with exploration and development would result in increased legal and possibly illegal harvest of fish from nearby drainages. Increased legal harvest would be a recreation benefit as fishing opportunities are more accessible to a wider range of people and game regulations are adapted to accommodate the increased fishing pressure. However, if increased illegal harvest causes fish populations to drop below a sustainable level, fishing as a recreational resource could be affected.

Increased access typically causes an increase in vandalism and the need for law enforcement. As recreation in public lands becomes more popular, undeveloped recreation sites would generally require more time and attention and have the potential to become developed sites, if use becomes concentrated to that level. Exploration and production activities may cause some ranches to be closed to hunting access via surface agreements.

Impacts From Management Specific to Each Alternative

Alternative A—No Action (Existing CBM Management)

Construction of roads, well pads and facility sites in designated recreation areas or immediately adjacent to them would detract from the quality of the recreation areas and diminish the quality of the recreational experience. Each well would present its own set of unique circumstances that would need to be mitigated to minimize impacts. Exploratory activities such as drilling and testing would temporarily displace game species locally. Since there would be no production activities in BLM planning areas under this alternative, there would not be any impacts from production on BLM land.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described above for recreation in general. If there were no CBM development on Tribal Lands, then there would be minimal impacts on recreation on the reservation. Impacts to hunting and fishing from trespassing could impact Native Americans who rely on these resources for subsistence purposes.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Conclusion

Cumulative impacts would include the effects of Alternative A combined with conventional oil and gas development and other projects discussed in the Minerals Appendix. These would include impacts from nearby activities such as mining or power generation facilities, which can result in increased use due to increases in population associated with additional available jobs. (Note: surface mining is preparing to expand by 4,000 acres under permit request now. See this chapter's *Introduction* section.)

Alternative B—Emphasize Soil, Water, Air, Vegetation, Wildlife, and Cultural Resources

Alternative B would allow development with single-lane roads and turnouts. Upon abandonment, new roads would be rehabilitated and closed. Impacts from this alternative would be similar to Alternative A with the addition of increased CBM development resulting in increased access, resulting in increased impacts on dispersed recreation activities such as hunting and fishing.

Crow Reservation

Most recreation resources on the reservation will not be affected by off-reservation development. Fragmentation of wildlife habitat by surface disturbances outside of the reservation may change wildlife migration patterns, which could affect on-reservation hunting.

Northern Cheyenne Reservation

Most recreation resources on the reservation will not be affected by off-reservation development. Fragmentation of wildlife habitat by surface disturbances outside of the reservation may change wildlife migration patterns, which could affect on-reservation hunting.

Conclusion

The residual impact of this alternative is increased CBM development, which could result in increased access to remote areas and increased vandalism.

Cumulative impacts under this alternative would be greater than those described under Alternative A.

Alternative C—Emphasize CBM Development

Impacts on recreation areas would be similar to Alternative B, but an increased number of disturbed acres and opportunities for access. Discharge of produced water directly to the ground could increase erosion. Increased erosion could lead to a reduced amount of land available for recreation activities and could disrupt habitat for game species.

Crow Reservation

Most recreation resources on the reservation will not be affected by off-reservation development. Fragmentation of wildlife habitat by surface disturbances outside of the reservation may change wildlife migration patterns, which could affect on-reservation hunting. The discharge of untreated CBM production water on ground surfaces within the reservation boundary (from development adjacent to the reservation) could lead to localized soil erosion, which could result in the creation of gullies and limited vegetation loss that could further alter wildlife habitat and change hunting opportunities.

Northern Cheyenne Reservation

Most recreation resources on the reservation will not be affected by off-reservation development. Fragmentation of wildlife habitat by surface disturbances outside of the reservation may change wildlife migration patterns, which could affect on-reservation hunting. The discharge of untreated CBM production water on ground surfaces within the reservation boundary (from development adjacent to the reservation) could lead to localized soil erosion, which could result in the creation of gullies and limited vegetation loss that could further alter wildlife habitat and change hunting opportunities.

Conclusion

The residual impacts of this alternative are similar to Alternative B. The greater surface disturbance from roads could increase the opportunity for access to remote areas. The discharge of water could increase erosion and damage lands used for recreation.

Cumulative impacts would be greater than those described under Alternative B, but on a large scale because of the emphasis on CBM development.

Alternative D—Encourage Exploration and Development While Maintaining Existing Land Uses

Impacts on recreation resources would be similar to Alternative B, but less because of water management measures to eliminate soil erosion by piping discharged water to the nearest body of water.

New oil and gas roads would remain open or closed at the surface owner's discretion. Open roads would create impacts; closed roads would prevent impacts.

Crow Reservation

Most recreation resources on the reservation will not be affected by off-reservation development. Fragmentation of wildlife habitat by surface disturbances outside of the reservation may change wildlife migration patterns, which could affect on-reservation hunting.

Northern Cheyenne Reservation

Most recreation resources on the reservation will not be affected by off-reservation development. Fragmentation of wildlife habitat by surface disturbances outside of the reservation may change wildlife migration patterns, which could affect on-reservation hunting.

Conclusion

The residual impacts of this alternative would be similar to those described under Alternative B. Cumulative impacts would be greater than those described under Alternative A because of the expanded CBM development.

Alternative E—Preferred Alternative

Alternative E, the Preferred Alternative, would allow CBM development subject to existing planning restrictions and balances CBM development and the protection of the natural environment. Impacts on recreation areas would include the loss of land for recreation purposes, and the disruption to recreation activities. Each well would present its own set of unique circumstances that would need to be mitigated to minimize impacts. Exploratory activities such as drilling and testing would temporarily displace game species locally. Impacts from surface disturbance would be minimized by using existing disturbances where possible. Because transportation corridors are not required, the number of disturbed acres and opportunities for access would be greater than Alternative B.

Crow Reservation

Most recreation resources on the reservation will not be affected by off-reservation development. Fragmentation of wildlife habitat by surface disturbances outside of the reservation may change wildlife migration patterns, which could affect on-reservation hunting.

Northern Cheyenne Reservation

Most recreation resources on the reservation will not be affected by off-reservation development. Fragmentation of wildlife habitat by surface disturbances outside of the reservation may change wildlife migration patterns, which could affect on-reservation hunting.

Conclusion

The residual impacts of this alternative are similar to Alternative B. Surface disturbance from roads would be greater than Alternative B, increasing the opportunity for access to remote areas.

Cumulative impacts would be similar to those described under Alternative B.

Social and Economic Values

Social and Economic Values *Socio-economics address the changes in demographics; social organization including housing attitudes, and lifestyles; economics such as employment, unemployment and per capita income; and, government revenue sources including taxes, state oil and gas lease income, federal mineral revenues and private landowner revenues.*
Alternative A **No Action (Existing CBM Management)**
• No social impacts (only small changes in employment, population, demand for services, etc.). • Small impact on economic conditions as a result of new production wells.
Alternative B **CBM Development with Emphasis on Soil, Water, Air, Vegetation, Wildlife and Cultural Resources**
• Social impacts would include new jobs and new population moving to the area. • Economic impacts include generation of new personal and government income. • Additional disposal costs associated with injection of producted water. • Additional demands on public services.
Alternative C **Emphasize CBM Development**
• Social impacts same as Alternative B. Increase in impacts on lifestyles and values. • Economic impacts same as Alternative B. Increase in impacts to water resource users.
Alternative D **Encourage CBM Exploration and Development While Maintaining Existing Land Uses**
• Social impacts same as Alternative B. Small increase in impacts on lifestyles and values. • Economic impacts same as Alternative B. Small increase in impacts to water resource users.
Alternative E **Preferred CBM Development Alternative**
• Social impacts same as Alternative B. Public burden to maintain roads may increase depending on landowner access decisions. • Economic impacts same as Alternative B, except that oil and gas income may be less depending on water treatment costs.

Assumptions

It is assumed that the average CBM production well in Montana produces about 125,000 cubic feet per day (MBOGC 2001a). Using a gas price of about $4.00 per thousand cubic feet, the average well would generate about $182,500 per year in total income. Income-producing wells on average are expected to last between 10 and 20 years, with an average production life of 15 years. Exploration wells do not produce income.

The social and economic analysis in this chapter is based on the RFD rate of development over a 20-year period. During this 20-year period, all CBM wells would be drilled and production would peak. However, because CBM wells typically produce for 10 to 20 years, a well drilled in year 20 would continue to produce until year 40. Thus, social and economic consequences of production and abandonment would continue for up to 20 more years beyond the period assessed here.

The number and type of jobs related to CBM development would vary with the project phase, exploration, development, production, or abandonment. During exploration and development, the majority of jobs created would be for well drillers and pipeline installers along with specialty positions such as land surveyors, supervisors, and geologists. A number of related support personnel (e.g., truck drivers and material handlers) would also be required during these activities. During production, most new jobs would be for maintenance and repair workers and their supervisors. During abandonment, field workers, support workers, and their supervisors would be in demand.

To simplify this analysis, all dollar amounts (e.g., wages and other project-related income) are reported in current dollars with no adjustment for inflation over time.

Impacts From Management Common to All Alternatives

Impacts on social conditions would include changes in employment and population; changes in the services provided by governments; the effects of drilling and related activities on rural lifestyles in the project area; the effects of changes in employment opportunities on communities; changes in levels of traffic, noise, visual resource impacts, and psychological stress levels; and the effects of population change on local housing, schools, and services.

The information reflected in the public comments and newspaper reports summarized in Chapter 3 indicate a range of attitudes and beliefs with respect to the development of CBM and its relationship to the lifestyles and values of area residents.

As discussed in Chapter 3, the majority of public comments received during scoping related to concerns about impacts on the environment, and water quality

and quantity in particular. The possibility of unfavorable economic impacts resulting from environmental impacts is also a concern. Other concerns include possible increases in traffic levels, noise, visual resource impacts, and psychological stress associated with changes to the surrounding built and natural environment.

Numerous social and cultural impacts have been predicted by Native Americans as a result of CBM development on adjacent fee, state and federal minerals. These potential impacts include: the lack of access to energy-related employment, population influx, over-commitment of Tribal revenue, abridged effectiveness of Tribal governments, stressed infrastructure and service related capacity, altered social organization and social well being perception, and the further influence of western culture resulting in changes to traditional beliefs and value systems.

Direct economic impacts of the project would include changes in personal income resulting from new employment of oil and gas workers; purchases of services from local area vendors; lease, royalty, and production payments; taxes and other government levies; impacts resulting from changes in environmental quality; and related changes in the fiscal health of county, state, and federal governments. Indirect impacts would include induced economic activity from local purchases of equipment, supplies, and services; induced economic activity from purchases of goods and services by project workers; and changes in the sources of income for local governments. The largest economic benefit from CBM development is the methane itself, measured by the revenues obtained by the companies involved in developing the resource. It is assumed that most of these revenues would go to out-of-state companies. Montana's share of that benefit would come mostly in the form of natural gas taxes and royalties, discussed below.

Conventional oil and gas development would have economic impacts on landowners, communities, county governments, reservations, and the state and Federal governments. When hydrocarbons are produced and sold, the operator is responsible for paying the mineral owner and governmental entities in the form of taxes and royalties. New employees generally would be needed as wells are added; for example, drilling contractors and other contractors would be required to service and supply the wells to maintain production. At the same time, an increase in wells would impact the community through an influx in population which, in turn, would result in increased pressure on community services such as schools, roads, medical facilities, and other public services.

Property values would be affected by full field development. Full-size ranches would be impacted by the increase in activity accompanying development. This could include such factors as the change in rural character of the land. Ranchers choosing to sell their ranches would receive less monetarily if the ranch sells without mineral rights attached. Outfitting would be impacted from increased road development, causing a decline in outfitting income.

Oil and gas development would impact social and economic resources through influence on area employment, taxes, Payments in Lieu of Taxes, royalties to mineral owners, and county, state, and federal services. It might also affect local environmental resources, from which many residents make their living. Conventional well development is projected at between 595 to 2,325 additional oil and gas wells over the next 20 years. This level of industrial activity (average 116 wells per year) would have negligible impact on the social economic resources of the area.

Impacts From Management Specific to Each Alternative

Alternative A—No Action (Existing CBM Management)

Employment and Unemployment

The location and distribution of the exploratory wells by county is not known, and therefore, this analysis assumes that the wells in the two RMPs are distributed across those areas and the wells to be drilled statewide are also distributed geographically in proportion to the RFD estimates for development. The production wells are assumed to be confined to the CX Ranch in Big Horn County.

Average numbers and types of jobs and their associated wages are estimated based on a recent report on the economic impacts of CBM development in the Powder River Basin (ZurMuehlen 2001), which assumes the following ratios: 49 jobs per 160 wells for exploration/development; 9 jobs per 160 wells for production; and 12 jobs per 160 wells for abandonment. As shown in Table 4-48, the estimated number of jobs created under Alternative A would range between 175 (Year 1) and 14 (Years 8 through 19), for an average of about 32 jobs per year over the period. This change would be small compared to the total employment in the CBM emphasis area (183,000 in 1998). For Alternative A, it is assumed

TABLE 4-48
ALTERNATIVE A: ESTIMATED WAGES AND JOBS FOR WELL DEVELOPMENT, PRODUCTION, AND ABANDONMENT
(WAGES REPORTED IN CONSTANT DOLLARS)[1]

Year	Wells Drilled per Year	Initial Development Jobs	Initial Development Wages[2]	Wells Producing per Year	Production Jobs	Production Wages	Wells Abandoned per Year	Abandonment Jobs	Abandonment Wages	Estimated Total Jobs	Estimated Total Wages
1	525	161	$4,662,656	250	14	$539,063				175	$5,201,719
2	150	46	$1,332,188	250	14	$539,063				60	$1,871,250
3	150	46	$1,332,188	250	14	$539,063				60	$1,871,250
4	100	31	$888,125	250	14	$539,063	375	28	$972,656	73	$2,399,844
5				250	14	$539,063	100	8	$259,375	22	$798,438
6				250	14	$539,063	100	8	$259,375	22	$798,438
7				250	14	$539,063	100	8	$259,375	22	$798,438
8				250	14	$539,063				14	$539,063
9				250	14	$539,063				14	$539,063
10				250	14	$539,063				14	$539,063
11				250	14	$539,063				14	$539,063
12				250	14	$539,063				14	$539,063
13				250	14	$539,063				14	$539,063
14				250	14	$539,063				14	$539,063
15				250	14	$539,063				14	$539,063
16				250	14	$539,063				14	$539,063
17				250	14	$539,063				14	$539,063
18				250	14	$539,063				14	$539,063
19				250	14	$539,063				14	$539,063
20				250	14	$539,063	250	19	$648,438	33	$1,187,500
20-Year Total	**925**	**283**	**$8,215,156**	**250**	**14[3]**	**$10,781,250**	**925**	**69**	**$2,399,219**	**634**	**$21,395,625**

NOTES:

[1]Data for jobs per well and wages (ZurMuehlen 2001).

[2]Wages paid for initial development phase for well drillers and pipeline installers was estimated at $6,600 per well (Langhus 2001)

[3]The same number of jobs are assumed to last for the duration of the planning period.

that all wells would be abandoned by year 20 of the project.

Measurable indirect changes to local employment would not be anticipated for Alternative A. The purchase of equipment, supplies, and services related to the proposed wells would have some impact but likely would not be distinguishable from the existing economic activity in the CBM emphasis area and in the state.

Thus, few or no new jobs would be created indirectly. New employment created directly and indirectly for Alternative A would be small in relation to total employment in the CBM emphasis area (183,000 in 1998), and therefore, it would not be expected to result in changes to current county or state unemployment rates.

Demographics

Employees who would fill the CBM jobs would likely be a mixture of current residents from the surrounding areas and those who would be drawn to the project and its employment opportunities from around the region. It is assumed that local labor (i.e., those within commuting distance of the CBM well locations) would be used to the extent available; however, many of the new jobs would likely be filled by new migrants to the region. The degree to which the jobs would be filled by current residents would depend on a number of factors, including job skills. The extent to which workers who move to the region for new jobs would bring families with them would depend on a number of factors, most notably the duration of the job in a given location. Assuming a mixture of single employees and those with families, it is estimated that, on average, each new employee would bring one additional person to the region. Even if all the jobs (175 during Year 1) were filled by new migrants to the region and resulted in new persons moving to the area, the total new population (perhaps 350 persons) would be small compared to the total regional population (287,000 in 2000). There would likely be some concentration of new residents associated with jobs in Big Horn County related to the CX Ranch. Given that any new population would be spread over both time and geographic area, no change in demographics would be anticipated from Alternative A.

Social Organization

Housing Units and Vacancy

Only small changes in the supply or demand of permanent or temporary housing are anticipated as part of Alternative A. This follows from the small changes in employment and population discussed above. However, there could be short term localized housing shortages depending on the size of the population increase in Big Horn County.

Public Services and Utilities

The relatively small scale of CBM well development would not result in any substantial changes in the ability of county, state, or Federal governments to provide public services or utilities. The basis for this conclusion is the lack of additional temporary or permanent population and the associated lack of demand for additional public services. However, there could be short term localized increases in public services demands depending on the size of the population increase in Big Horn County.

Attitudes, Beliefs, Lifestyles, and Values

The limited development of CBM proposed for Alternative A likely would be experienced by the communities in the CBM emphasis area as a continuation of existing oil and gas development practices in the region and in the state. As a result, these actions by themselves would likely be perceived as generally consistent with the attitudes, beliefs, lifestyles, and values of most population groups (e.g., ranchers, Native Americans, small town residents).

Personal Income

Wages paid to project employees would contribute to the total personal and per capita income of every county where employees reside. As shown in Table 4-48, total direct wages from Alternative A over 20 years are estimated at about $21 million, and would range from a high of $5.2 million (Year 1) to a low of $539,000 (Years 8 through 19).

Any of the producing wells proposed for operation on the CX Ranch would generate new personal income, depending on ownership. Individuals who own the mineral rights to their land and lease those rights to developers as part of the existing management scenario would receive additional income from rents or royalties. Although only a small percentage of landowners own mineral rights, the royalty income to any one individual would still be substantial over many years if a given well is highly productive. Individuals on whose land CBM is developed but who do not own the mineral rights to their land would receive one-time payments as compensation for land disturbance. However, given the small scale of production anticipated, these changes to personal income likely would have only a small effect on the per capita

income of the CBM emphasis area or the state as a whole.

Additional personal income for residents of the counties and the state would be generated by circulation and re-circulation of dollars paid out as business expenditures and as state and local taxes.

Government Revenues

The primary source of government revenues generated by the project would be from taxes levied on property, equipment, income, and natural gas output generated by production wells. Exploratory wells would generate government income only to the extent the associated temporary facilities are subject to local property taxes.

Oil and Gas Income

Royalties of 12.5 percent are typically earned for oil and gas production on state and federal lands. About 50 percent of royalties paid to the federal government are generally returned to the state from which they originate. Assuming the 250 production wells on the CX Ranch proposed for Alternative A each generate about $182,500 in gross production income per year (assuming production of 125,000 cubic feet per day and a price of $4.00 per thousand cubic feet), the total annual gross income would be about $45.6 million per year for an average of 15 years. About 12.5 percent, or $5.7 million, of this new income would accrue to the state, federal, or private mineral owner annually.

Rents on state and federal lands leased for oil and gas development are bid competitively, with the lowest bid being $1.50 per acre. Resulting government income would depend on the specifics of leases on the CX Ranch; however, it is assumed that additional income would accrue to the state and federal government.

Taxes

Income Taxes

A portion of the taxable income (wages, rent or royalty income, and land disturbance payments) generated by Alternative A would accrue to the state as income tax revenue. Income taxes would be paid on the annual wages paid for the average 32 jobs per year discussed under *Employment*. Dividing the estimated total wages over 20 years by the estimated total jobs for the same period (Table 4-48), the average annual salary per job would be about $34,000. Income in Montana is taxed according to a graduated rate structure with rates ranging from 2 percent to 11 percent of taxable income; the average rate in 2000 was about 3 percent (Montana Department of Revenue 2001). It is important to note that these sums are already included in the estimates of personal income (income taxes are a transfer of personal income to the state). Thus, estimated income tax revenues from an annual average of 32 jobs at $34,000 would range from $21,800 (2 percent tax rate) to $119,700 (11 percent tax rate), with a likely amount closer to $32,600 (3 percent tax rate) based on recent history. The project would result in an increase in state tax revenues to the extent that new income is created that didn't previously exist in the state.

Property Taxes

Both real and personal property are subject to property taxes. Personal property would consist of structures, equipment, and materials used for the proposed exploration and production of CBM. Taxes on real property would be based on changes in the assessed value that result from improvements to the property. Each county in which facilities were located would assess tax levies and apply them to the taxable value of the relevant facilities. The levy would be based on the total value of property multiplied by a tax rate or rates specific to the property location (i.e., county and special service districts). Any such additional property taxes would contribute new income directly to both the county tax base and the local economy. It should be noted that property taxes on business equipment (e.g., drilling equipment) would likely be phased out by 2006, reducing the total taxes that would be collected.

Given the limited nature of CBM exploration and development proposed in Alternative A, changes in taxes are not expected to be substantial for any given county. The exception is Big Horn County, where the new production wells are proposed. Additional county tax revenues would be anticipated. Property tax revenues would be a cost to CBM development companies and landowners and a benefit to the counties and the state.

Natural Resources Taxes

The products of natural resource extraction in Montana, including natural gas, are subject to state natural resource taxes, including local government severance taxes. Any new production of natural gas generated by the 250 production wells in Big Horn County would be subject to such taxes. Severance taxes are distributed to a variety of state and local funds and would contribute positively to the state and local economies.

Other Taxes

In general, the local and state economies would benefit from sales of goods and services by local businesses to oil and gas operators associated with the project. However, because there is no sales tax in Montana, local sales of goods and services associated with CBM development would not generate increases in tax revenues.

Water Resource Values

The purpose of a discussion of water resource values in the *Economics* section of this report is to acknowledge that the existing surface and groundwater resources in the CBM emphasis area have an economic value that is part of the overall economy of the area and that alterations to these resources, would have economic impacts to water users or to the regional economy. Affected users would include those who depend on surface water or groundwater for irrigation, ranching, municipal water needs, home water needs, landscape needs, and any other business and household need of water from a surface water body or well.

Given the relatively limited scale of CBM development proposed for Alternative A, effects on water resources and water resources economics would be relatively limited (see the analysis in the Hydrological Resources section). For Alternative A, untreated water from exploration would be placed in holding facilities for beneficial re-use, which would provide an economic benefit to affected water users. No discharge to waters of the United States would be allowed for BLM-authorized exploration wells; the state would permit discharge for the CX Ranch field of up to 1,600 gpm. Because of the small scale, no economic impacts to downstream surface water users would be anticipated.

Localized groundwater depletion would result over time (more than 5 years) from the CBM wells proposed for Alternative A.

Crow Reservation

Impacts to social and economic values on the Crow Reservation would be small because it is assumed that no CBM wells would be developed on the Reservation initially. Social impacts would be more likely to affect those individuals living off the reservations or whose activities are conducted off the reservations. Native American development is considered as part of the cumulative effects potential. Few, if any, tax revenues would accrue to Tribal governments as a result of off-reservation CBM development. It is likely that a smaller number of Native Americans who are interested in the development of energy resources for the long-term social and economic betterment of tribal members would perceive or experience fewer impacts from CBM development.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be small because it is assumed that no CBM wells would be developed on the Reservation. Social impacts would be more likely to affect those individuals living off the reservations or whose activities are conducted off the reservations. Native American development is considered as part of the cumulative effects potential. Few, if any, tax revenues would accrue to Tribal governments as a result of off-reservation CBM development. It is likely that a smaller number of Native Americans who are interested in the development of energy resources for the long-term social and economic betterment of tribal members would perceive or experience fewer impacts from CBM development.

Conclusions

The alternate management scenario is a continuation of existing oil and gas industry practices in the CBM emphasis area and would not result in social impacts. They would be only a small effect on economic conditions in the CBM emphasis area, as well as environmental and social conditions. However, there could be short term localized impacts to housing and services in Big Horn County.

The new jobs and related social and economic impacts from Alternative A would be small, with the exception of the proposed production wells in Big Horn County, which would result in positive economic impacts in that county. Future development in the area, such as further expansion of existing surface coal mines, would likely have larger social and economic impacts (e.g., creation of more jobs and income) than those impacts from Alternative A.

Alternative B—Emphasize Soil, Water, Air, Vegetation, Wildlife, and Cultural Resources

Employment and Unemployment

Estimated direct employment from CBM under the development scenario for the 20-year project life is presented in Table 4-49. (Wage information is discussed under *Economics*.) The number and type of jobs involved would vary with the project phase. The

TABLE 4-49
ALTERNATIVES B, C, D, and E: ESTIMATED WAGES AND JOBS FOR WELL DEVELOPMENT, PRODUCTION, AND ABANDONMENT (WAGES REPORTED IN CONSTANT DOLLARS)[1, 2]

Year	Wells Drilled per Year	Initial Development Jobs	Initial Development Wages[3]	Wells Producing per Year	Production Jobs	Production Wages	Wells Abandoned per Year	Abandonment Jobs	Estimated Abandonment Wages	Estimated Total Jobs	Estimated Total Wages
1	900	276	$7,993,125	510	29	$1,099,688	390	29	$1,011,563	334	$10,104,375
2	1,100	337	$9,769,375	1,220	69	$2,630,625	390	29	$1,011,563	435	$13,411,563
3	2,000	613	$17,762,500	2,830	159	$6,102,188	390	29	$1,011,563	801	$24,876,250
4	2,200	674	$19,538,750	4,640	261	$10,005,000	390	29	$1,011,563	964	$30,555,313
5	2,000	613	$17,762,500	6,250	352	$13,476,563	390	29	$1,011,563	993	$32,250,625
6	1,500	459	$13,321,875	7,750	436	$16,710,938	0	0	$0	895	$30,032,813
7	1,300	398	$11,545,625	9,050	509	$19,514,063	0	0	$0	907	$31,059,688
8	900	276	$7,993,125	9,950	560	$21,454,688	0	0	$0	835	$29,447,813
9	900	276	$7,993,125	10,850	610	$23,395,313	0	0	$0	886	$31,388,438
10	700	214	$6,216,875	11,550	650	$24,904,688	0	0	$0	864	$31,121,563
11	550	168	$4,884,688	11,900	669	$25,659,375	200	15	$518,750	853	$31,062,813
12	550	168	$4,884,688	12,250	689	$26,414,063	200	15	$518,750	873	$31,817,500
13	550	168	$4,884,688	12,600	709	$27,168,750	200	15	$518,750	892	$32,572,188
14	550	168	$4,884,688	12,950	728	$27,923,438	200	15	$518,750	912	$33,326,875
15	550	168	$4,884,688	13,300	748	$28,678,125	200	15	$518,750	932	$34,081,563
16	450	138	$3,996,563	13,550	762	$29,217,188	200	15	$518,750	915	$33,732,500
17	450	138	$3,996,563	13,800	776	$29,756,250	200	15	$518,750	929	$34,271,563
18	450	138	$3,996,563	14,050	790	$30,295,313	200	15	$518,750	943	$34,810,625
19	400	123	$3,552,500	14,100	793	$30,403,125	350	26	$907,813	942	$34,863,438
20	300	92	$2,664,375	14,050	790	$30,295,313	350	26	$907,813	908	$33,867,500
20-Year Total	18,300	5,604	$162,526,875		11,090	$425,104,688		319	$11,023,438	17,013	$598,655,000
Annual Average	915	280	$8,126,343.75		554	$21,255,234.38		16	$551,171.88	851	$29,932,750

NOTES:

[1]Data for jobs per well and wages (ZurMuehlen 2001).

[2]The water management conditions included in Alternative B would require injection wells, the installation and operation of which would be associated with additional jobs. Water injection wells would be required at a rate of about 1 per 10 CBM wells. This would result in an increase in jobs and wages of about 10% over those reported in Table 4-26 for all phases of the project combined.

[3]Wages paid for initial development phase for well drillers and pipeline installers was estimated at $6,600 per well (Langhus 2001).

types of jobs would be the same as those described for Alternative A.

As shown in Table 4-49, development (drilling of about 18,300 wells over 20 years) would result in an estimated average of 851 jobs per year, with a range from 334 (Year 1) to 943 (Year 18) for all project phases combined. The actual number of jobs in a given year would depend on the actual number of wells drilled, in production, or abandoned in that year. Abandonment of wells during years 21-40 would result in an estimated 1,054 additional jobs, for an average of about 53 jobs per year during that period.

The additional jobs created would be small compared to the total employment in the CBM emphasis area (183,000 in 1998). However, given that most of the CBM wells would be located in three counties (Big Horn, Powder River, and Rosebud), a large number of the jobs would be concentrated in those counties. Because some of these jobs would go to non-local residents, the actual number of new jobs in the study area would be less.

The water management conditions included in Alternative B would require injection wells, the installation and operation of which would be associated with additional jobs. Water injection wells would be required at a rate of about 1 per 10 CBM wells. This would result in an increase in jobs and wages of about 10 percent over those reported in Table 4-49 for all phases of the project combined.

In addition to the direct jobs created by the project, some additional jobs would be created indirectly through additional work for persons in related support industries such as truckers, material suppliers, inspectors, and various other specialists. One estimate is that one indirect job would be created for every four direct jobs created (ZurMuehlen 2001).

The effect of the new jobs on current unemployment rates in the area would be moderate. Although the new direct jobs would help boost total employment in the emphasis area, the increases would be limited to those sectors and individuals with the appropriate skills for the jobs and to those geographic locations where the jobs are located. For example, the relatively high unemployment rates (about 9 percent) in the mining sector in Big Horn and Rosebud counties would be decreased if unemployed persons gain employment from the new CBM development.

Any new jobs filled by new residents (see the *Demographics* section) would increase the number of employed persons in a given county but would not decrease the number of unemployed persons. To the extent that indirect jobs are created by the project, some increased employment in other service industries also would occur.

Demographics

As with Alternative A, employees who would fill the CBM jobs would likely be a mixture of current residents from the surrounding areas and those who would be drawn to the project and its employment opportunities from around the region. It is assumed that local labor would be used to the extent it is available; however, for Alternative B it is likely that many additional workers (e.g., drill rig crews) from outside the area would be needed, especially during the peak employment years of the project. It is assumed that drill rigs from a variety of locations-both Montana and Wyoming-would be used, depending on supply and demand at any given time. The potential for new population is greatest in the counties where the number of CBM wells to be drilled is greatest: Big Horn, Powder River, and Rosebud counties (about 90 percent of proposed CBM wells would be drilled in these three counties; see Table 4-50). As with Alternative A, it is estimated that, on average, each new employee would bring one additional person to the region. Assuming, for example, that all of the jobs were filled by new migrants to the area, as many as 1,986 people (993 x 2) might be added to the region during the peak employment year (Year 5). An increase of this magnitude would be small compared to the total regional population (287,000 in 2000). However, the new population could be concentrated in the three counties with the most CBM wells (see Table 4-50).

Because these three counties have a relatively small combined population (about 24,000), population change within these counties could be substantial. Of the approximately 24,000 persons in the three counties, about 10,400 or 44 percent are Native American (see Chapter 3).

Social Organization

Housing Units and Vacancy

Depending on the type and duration of the jobs (e.g., long-term production supervisor versus drill rig crew member), new employees in the area would seek either temporary housing (hotels, apartments, trailer parking) or permanent housing (homes to purchase or to rent

TABLE 4-50
TOTAL PROPOSED WELLS AND PERCENT BY COUNTY
(ALTERNATIVES B, C, D, AND E)

County	Wells to be Drilled	Percent of Total
Big Horn	7,000	38.3%
Blaine	10	0.1%
Carbon	400	2.2%
Carter	0	0.0%
Custer	300	1.6%
Gallatin	15	0.1%
Golden Valley	0	0.0%
Musselshell	150	0.8%
Park	25	0.1%
Powder River	6,700	36.6%
Rosebud	2,800	15.3%
Stillwater	700	3.8%
Sweetgrass	25	0.1%
Treasure	25	0.1%
Wheatland	0	0.0%
Yellowstone	150	0.8%
Subtotal	18,300	100.0%
Combined Total:	16,500	90.2%
Big Horn, Powder River, and Rosebud counties		

long-term). Individual choices about where to live are hard to predict and vary with personal preference, in addition to the supply of housing and availability of services in a given location and the mobility demands of a given job. The relatively limited supply of temporary and permanent housing in the smaller communities in the CBM emphasis area would limit the number of new employees (and families, if applicable) who would be able to live there without additional housing and related services. The larger communities, such as Billings or Gillette and Sheridan, Wyoming, have a greater supply of temporary and permanent housing and would be likely settlement locations for people employed by the CBM industry. In part because of the general trend of migration within Montana from the east to the west during recent years, vacant housing is available in a number of communities. As discussed in Chapter 3, vacancy rates for both temporary and permanent housing are adequate to high in the CBM emphasis area. This information, combined with the large size of the geographic area and the dispersed nature of the new job opportunities and associated new population, suggest that adequate housing opportunities would be available in the larger communities but might not be available in some of the smaller communities.

Public Services and Utilities

Impacts on the ability of local governments to provide public services and utilities would be related to the ability of the service providers to adapt to relevant fiscal or physical changes from CBM development. Affected services typically include police and fire protection, emergency medical services, schools, public housing, park and recreation facilities, water supply, sewage and solid waste disposal, libraries, roads, and other transportation infrastructure. Given the large geographic scale of the CBM development scenario, it is infeasible to quantitatively assess the relationship of the project to these individual services. Effects would be greatest in the three counties (Big Horn, Powder River and Rosebud) where most of the CBM wells are proposed to be drilled; however, these counties would also receive the greatest amounts of property tax and other government revenues (see the

Economics section) that would fund improvements or other changes to services.

The alternatives being considered include varying management objectives with respect to the construction of roads and utilities. The construction and maintenance of utilities would be funded by the users. The decision as to whether to maintain roads upon abandonment of CBM facilities would be up to the land owner, which could be either a public or private entity. To the extent local governments opt to maintain these roads after this time, additional revenue would be required to balance the additional costs required to do so.

Attitudes, Beliefs, Lifestyles, and Values

The large scale development of a large number of CBM wells in the planning area would likely conflict with the attitudes, beliefs, lifestyles, and values of many individuals and population subgroups in the area (e.g., farmers, ranchers, small town residents, Native Americans, retirees, etc.). Drilling, testing, and operation of CBM wells would result in increased traffic from trucks and other vehicles; noise from traffic and the operation of generators and drilling and other equipment; visual resource impacts from the construction of the wells themselves as well as power lines and related electrical infrastructure; and psychological stress associated with unwanted change, division in the community, or other impacts. The population subgroups would be affected to the degree to which their lifestyles and values are inconsistent with such impacts.

The majority of individuals in the planning area are understood to have traditional rural lifestyles in which the relatively quiet and pristine surroundings are an important value. They would likely find CBM development inconsistent with the desired balance between environmental stewardship and economic development expressed in many of the scoping comments and newspaper reports. This would be particularly true for Big Horn, Powder River, and Rosebud Counties where the majority of the wells would be developed. Large-scale CBM development could be viewed as part of a gradual transition away from traditional rural and agricultural lifestyles. A smaller group of people in the area who are more interested in the potential economic benefits of CBM development would likely perceive or experience fewer impacts with respect to lifestyles and values.

Large-scale CBM development is likely to conflict to some degree with traditional Native American values which emphasize preservation of cultural heritage and a reverence for the natural environment. Native American groups could be affected by increases in noise, impacts on visual resources and plant populations, etc., in particular as they affect locations and resources used for spiritual or religious purposes. It is assumed that no CBM wells would be developed on the Native American reservations initially, and therefore impacts would be more likely to affect those individuals living off the reservations or whose activities are conducted off the reservations. Native American development is considered as part of the cumulative effects impact potential. It is likely that a smaller number of Native Americans who are interested in the development of energy resources for the long-term social and economic betterment of tribal members would perceive or experience fewer harmful impacts from CBM development.

Impacts on recreation areas would include the loss of land for recreation purposes, and the disruption to recreation activities. Each well would present its own set of unique circumstances that would need to be mitigated to minimize impacts. Exploratory activities such as drilling and testing would temporarily displace game species locally.

The subsurface discharge of produced water would likely be seen as consistent or somewhat inconsistent with the desired balance between environmental stewardship and economic development expressed in many of the scoping comments and newspaper reports. Impacts on groundwater would be the same for Alternatives B, C, D, and E, with the primary impact being the drawdown of groundwater.

Personal Income

Wages paid to CBM workers would contribute to the total personal income in the county where the employees reside. As shown in Table 4-49, wages would be generated from all three project phases. Over the first 20 years of the project, total wages paid for all phases of the project would be an estimated $598 million. Estimated annual wages would range from $10 million in Year 1 to almost $35 million in Years 18 and 19. Although this much estimated personal income would be generated by the project, it would not all be experienced as “new” income within a given county or the state. New income would be the difference between the income of workers before CBM development and the income after CBM development.

A number of the producing wells in the development scenario would generate new personal income for those who own the land or the mineral rights, as stated under Alternative A. The circulation and re-circulation of direct income (including royalties to private owners)

generated by the project would generate additional (indirect) personal income throughout the region.

Government Revenues

Oil and Gas Income

Assuming each of the approximately 16,500 production wells anticipated for Alternative B generate about $182,500 in gross production income per year of operation, the total annual gross income would vary depending on the number of wells in production in a given year. As shown in Table 4-49, the estimated number of producing wells ranges from 510 in Year 1 to 14,100 in Year 19. It follows that the estimated annual gross income would range from $93 million (Year 1) to $2.5 billion (Year 19). Most of this revenue would go to methane companies and would accrue to the companies in the states where they are located. The 12.5 percent royalty collected on this annual income would range from about $12 million (Year 1) to $322 million per year. It is estimated that about one-half the well sites would be permitted on minerals administered by the federal government (BLM) about 5 to 10 percent on state (fee) minerals, and the remaining 40 to 50 percent on private minerals. As a result, about half of the royalty income would initially go to the federal government, with about half of the federal half being returned to the state. Thus, an estimated 30 to 35 percent of royalty income, between $4 million and $113 million in a given year, ultimately would accrue to the state. Given that total state revenues received from minerals management on state lands in FY 2000 was $11.6 million and total federal mineral revenues collected on Montana lands and disbursed to the state were $20.4 million in FY 2000 (see Chapter 3), new state revenues from CBM would be substantial, especially during the peak years of the project.

Rents on state and federal lands leased for oil and gas development are bid competitively, with the lowest bid being $1.50 per acre. Resulting government income would depend on the specifics of the leases. It is assumed that additional income would accrue to the state and federal government from these rents.

Net government revenues would be reduced by costs incurred for monitoring and regulating CBM activity. These costs would be relatively small compared to the revenues generated.

Water treatment costs for Alternative B would be greater than for Alternative D and much greater than for Alternative C.

Taxes

Income Taxes

A portion of the taxable income (wages, rent or royalty income, and land disturbance payments) generated by Alternative B would accrue to the state as income tax revenue. Income taxes would be paid on the annual wages paid for the average 851 jobs per year discussed above under *Employment*. Dividing the estimated total wages over 20 years by the estimated total jobs for the same period (Table 4-49), the average annual salary per job would be about $35,000 (does not account for inflation over time). Income in Montana is taxed according to a graduated rate structure with rates ranging from 2 percent to 11 percent of taxable income; the average rate in 2000 was about 3 percent (Montana Department of Revenue 2001). It is important to note that these sums are already included in the estimates of personal income (income taxes are a transfer of personal income to the state). Thus, estimated income tax revenues from an annual average of 851 jobs at $35,000 would range from $596,000 (2 percent tax rate) to $3.3 million (11 percent tax rate), with a likely amount closer to 894,000 (3 percent tax rate) based on recent history. As discussed above, the project would generate new income tax revenue for the state to the extent that revenue generated by new jobs, for example, exceeds existing tax revenues. The income tax sums are already included in the estimates of personal income.

Property Taxes

See general discussion of property taxes for Alternative A. Only at the time when a given property is improved (i.e., a CBM well or other facilities are developed there) would estimated new property tax revenues be calculated. However, property taxes would accrue to counties roughly in proportion to the number of new wells. Big Horn, Powder River, and Rosebud counties would have the vast majority of new wells; therefore, they would be anticipated to experience the greatest increases in assessed values and the greatest increase in new county property tax revenues. These new revenues could help improve schools, roads, community services, and other county assets, after any new costs associated with CBM are accounted for.

Natural Resources Taxes

Natural resources taxes would be greater than described under Alternative A because they would be based on 18,000 wells.

Other Taxes

Other taxes would be the same as described under Alternative A.

Water Resource Values

Surface discharge of produced water would be prohibited, and therefore surface water impacts such as erosion and water quality would be avoided. In the absence of surface water impacts, no associated economic impacts to surface water users would occur.

The primary impact to groundwater resources is removal of groundwater in the Powder River Basin watersheds affecting wells and springs.

Crow Reservation

Social and economic impacts from off-Reservation development in Alternative B would include creation of a limited number of new jobs in the emphasis area and related demographic shifts from people moving to the area. It is anticipated that the impact of added employment and population on social conditions on the Crow Reservation would be small. Some new personal and government income would be generated as discussed above. The effect of this new income on the Reservation would depend on a number of factors, including the extent to which Reservation members participate in the off-Reservation jobs or mineral ownership. Some additional demands on public services also would result.

See the Attitudes, Beliefs, Lifestyles and Values section under this alternative for additional information on effects to Native Americans.

As shown in the RFFA, 4,000 wells could be developed on the Crow Reservation. If this entire number of wells were developed, additional economic impacts would occur. Such impacts would generally be in the form of new jobs and employment opportunities, a drawdown in groundwater, and additional personal income and revenues from CBM development and production.

Indian allottees, and the Crow Tribe would receive access, damage payments, royalties, and possible taxes revenues.

Northern Cheyenne Reservation

Social and economic impacts from off-Reservation development in Alternative B would include creation of a limited number of new jobs in the emphasis area and related demographic shifts from people moving to the area. It is anticipated that the impact of added employment and population on social conditions on the Northern Cheyenne Reservation would be small. Some new personal and government income would be generated as discussed above. The effect of this new income on the Reservation would depend on a number of factors, including the extent to which Reservation members participate in the off-Reservation jobs or mineral ownership. Some additional demands on public services also would result.

See the Attitudes, Beliefs, Lifestyles and Values section under this alternative for additional information on effects to Native Americans.

As shown in the RFFA, 4,000 wells could be developed on the Northern Cheyenne Reservation. If this entire number of wells were developed, additional economic impacts would occur. Such impacts would generally be in the form of new jobs and employment opportunities, a drawdown in groundwater, and additional personal income and revenues from CBM development and production.

Indian allottees, and the Northern Cheyenne Tribe would receive access, damage payments, royalties, and possible taxes revenues.

Conclusion

The primary social impacts identified from Alternative B would be the new jobs created in the emphasis area as a result of development and change from a predominantly rural and agricultural based lifestyle. These new jobs would result in some demographic shifts as a result of people moving to the area. It is anticipated that the impact of added employment and population on social conditions would be small overall but that impacts in the three counties with the most CBM activity could be greater. Alternative B would result in the generation of new personal and government income. New personal income would include the wages from both direct and indirect jobs created by the project, as well as income from land disturbance payments and mineral leases. Similarly, new local, state, and federal government income would be generated through the variety of means discussed. Over the long term, there is the possibility of a “boom and bust” cycle as CBM activity rises and falls.

As shown in the RFD scenario presented in the Minerals Appendix, in addition to the 18,300 CBM wells considered for Alternative B, an additional 8,200 CBM wells would be developed in this area in the future: 4,000 on the Northern Cheyenne Reservation, 4,000 on the Crow Reservation, and about 200 wells on USFS land. This number is about 44

percent of those proposed for Alternative B. If this entire number of wells was developed over the same 20-year period as the other 18,300 wells, additional economic impacts would occur. Such impacts would generally be in the form of new jobs and employment opportunities, additional population, additional demands on public services, a drawdown in groundwater, and additional personal income and government revenues from CBM development and production. Potentially large social and economic impacts also would result from other developments proposed for the area, including expansion of existing surface coal mines. The impacts from these other developments would be additive to those identified above for Alternative B.

Alternative C—Emphasize CBM Development

Employment And Unemployment

Employment and unemployment would be the same as described under Alternative B, except that there would be no additional jobs created from installation of injection wells, which would not be required for this alternative.

Demographics

Demographics would be the same as described under Alternative B.

Social Organization

Housing Units and Vacancy

Housing units and vacancy would be the same as described under Alternative B.

Public Services and Utilities

Public services and utilities would be the same as described under Alternative B.

Attitudes, Beliefs, Lifestyles, and Values

General impacts on population subgroups are the same as for Alternative B.

Impacts on recreation areas would include the loss of land for recreation purposes, and the disruption to recreation activities. Each well would present its own set of unique circumstances that would be mitigated to minimize impacts. Exploratory activities such as drilling and testing would temporarily displace game species locally.

Alternative C would allow discharge of untreated water to the land surface. As indicated in the Hydrological Resources section, this discharge would result in erosion and water quality impacts. Such impacts would be inconsistent with the desired balance between environmental stewardship and economic development expressed in many of the scoping comments and newspaper reports. The primary reasons for this conclusion include the potentially large scale of this discharge, the potential for degraded water to negatively affect farming and ranching operations (e.g., reduce economic viability), increased noise, loss of natural scenery, and the inconsistency of this approach with the rural lifestyles and values discussed in Chapter 3.

Personal Income

Personal income would be the same as described under Alternative B, with the possible exception of decreases in farming or ranching income as a result of water quality and erosion impacts. See the Attitudes, Beliefs, Lifestyles and Values section under this alternative for additional information on social effects to lifestyles and Values.

Government Revenues

Government revenues would be the same as described under Alternative B.

Oil and Gas Income

Oil and gas income would be about the same as described under Alternative B. Water treatment costs would be less than for Alternative B due to the allowance of discharge to the land surface (see Water Resource Values below).

Taxes

Income Taxes

Income taxes would be the same as described under Alternative B.

Property Taxes

Property taxes would be the same as described under Alternative B.

Natural Resources Taxes

Natural resources taxes would be the same as described under Alternative B.

Other Taxes

Other taxes would be the same as described under Alternative B.

Water Resource Values

See the discussions for Alternative B. Alternative C would allow discharge of untreated water to the land surface. As indicated in the Hydrological Resources section elsewhere in this document, this discharge would result in erosion and water quality impacts. In turn, some downstream surface water users who depend on surface water resources for their livelihood would be affected (for example, if suitable irrigation water were no longer available or if ranch land were lost to erosion). See further discussion under Attitudes, Beliefs, Lifestyles and Values, above. Groundwater impacts would be similar to Alternative B. A difference is that no groundwater would be reinjected as it would for Alternative B, possibly increasing the risk of groundwater drawdown in some locations.

Crow Reservation

Impacts from Alternative C would include creation of a limited number of new jobs in the emphasis area and related demographic shifts from people moving to the area. The impact of added employment and population on social conditions on the Crow Reservation would be small. Some new personal and government income would be generated as discussed above. The effect of this new income on the Crow Reservation would depend on a number of factors, including the extent to which Reservation members participate in the off-Reservation jobs or mineral ownership. Additional demands on public services also would result. Somewhat greater impacts on water resource users and on lifestyles and values would occur compared to Alternative B. See the Attitudes, Beliefs, Lifestyles and Values section under this alternative for additional information on social effects to Native Americans.

Northern Cheyenne Reservation

Social and economic impacts from development in Alternative C would include creation of a limited number of new jobs in the emphasis area and related demographic shifts from people moving to the area. The impact of added employment and population on social conditions on the Northern Cheyenne Reservation would be small. Some new personal and government income would be generated as discussed above. The effect of this new income on the Northern Cheyenne Reservation would depend on a number of factors, including the extent to which Reservation members participate in the off-Reservation jobs or mineral ownership. Additional demands on public services also would result. Somewhat greater impacts on water resource users and on lifestyles and values would occur compared to Alternative B. See the Attitudes, Beliefs, Lifestyles and Values section under this alternative for additional information on social effects to Native Americans.

Conclusions

Residual impacts would be similar to those for Alternative B, except for impacts to lifestyles and water resource values, which would be greater for Alternative C than for Alternative B.

Cumulative impacts would be greater than for Alternative B, given the water resource impacts.

Alternative D—Encourage Exploration and Development While Maintaining Existing Land Uses

Employment and Unemployment

Employment and unemployment would be the same as described for Alternative B.

Demographics

Demographics would be the same as described under Alternative B.

Social Organization

Housing Units and Vacancy

Housing units and vacancy would be the same as described under Alternative B.

Public Services and Utilities

Public services and utilities would be the same as described under Alternative B.

Attitudes, Beliefs, Lifestyles, and Values

General impacts on population subgroups are the same as for Alternative B.

Impacts on recreation areas would include the loss of land for recreation purposes, and the disruption to recreation activities. Each well would present its own set of unique circumstances that would be mitigated to minimize impacts. Exploratory activities such as drilling and testing would temporarily displace game species locally.

Treatment of most produced water and discharge via pipeline or other constructed water courses would eliminate most of the erosion and water quality impacts.

Personal Income

Personal income would be the same as described under Alternative B, with the possible exception of decreases in farming area ranching income as a result of water quality and erosion impacts. See the Attitudes, Beliefs, Lifestyles and Values section under this alternative for additional information on social effects to lifestyles and Values.

Government Revenues

Government revenues would be the same as described under Alternative B.

Oil and Gas Income

Oil and gas income would be the same as described under Alternative B. Water treatment costs would be greater than for Alternative C and much less than for Alternative B.

Taxes

Income Taxes

Income taxes would be the same as described under Alternative B.

Property Taxes

Property taxes would be the same as described under Alternative B.

Natural Resources Taxes

Natural resources taxes would be the same as described under Alternative B.

Other Taxes

Other taxes would be the same as described under Alternative B.

Water Resource Values

See discussion for Alternatives B and C. Most discharge would be treated and carried over land in pipes. Surface water impacts and the potential for resulting economic impacts to surface water users would be less than for Alternative C and greater than for Alternative B. Groundwater impacts would be the same as Alternative C.

Crow Reservation

Impacts from Alternative D would include creation of a limited number of new jobs in the emphasis area and related demographic shifts from people moving to the area. It is anticipated that the impact of added employment and population on social conditions on the Crow Reservation would be small. Some new personal and government income would be generated as discussed above. The effect of this new income on the Crow Reservation would depend on a number of factors, including the extent to which Reservation members participate in the off-Reservation jobs or mineral ownership. Additional demands on public services also would result. Additional impacts on water resource users and on lifestyles and values would occur but they would be less than for Alternative C. See the Attitudes, Beliefs, Lifestyles and Values section under this alternative for additional information on social effects to Native Americans.

Northern Cheyenne Reservation

Social and economic impacts from Alternative D would include creation of a limited number of new jobs in the emphasis area and related demographic shifts from people moving to the area. It is anticipated that the impact of added employment and population on social conditions on the Northern Cheyenne Reservation would be small. Some new personal and government income would be generated as discussed above. The effect of this new income on the Reservation would depend on a number of factors, including the extent to which Reservation members participate in the off-Reservation jobs or mineral ownership. Additional demands on public services also would result. Additional impacts on water resource users and on lifestyles and values would occur but they would be less than for Alternative C. See the Attitudes, Beliefs, Lifestyles and Values section under this alternative for additional information on social effects to Native Americans.

Conclusions

Residual impacts would be similar to those for Alternative B, except with respect to impacts on water resource economics and related lifestyle impacts, which would be less than Alternative C but greater than Alternative B.

Cumulative impacts would be less than Alternative C and somewhat greater than Alternative B, given the differences in water resource impacts.

Alternative E—Preferred Alternative

Employment and Unemployment

Employment and unemployment would be the same as described under Alternative B. It is assumed that the approximate number of additional jobs created from installation of injection wells required for Alternative B would also occur for Alternative E, except that some of the jobs would be associated with the variety of site-specific produced water management options.

Demographics

Demographics would be the same as described under Alternative B.

Social Organization

Housing Units and Vacancy

Housing units and vacancy would be the same as described under Alternative B.

Public Services and Utilities

Public services and utilities would the same as described under Alternative B, except that the oil and gas roads would remain open or be closed at the surface owner's discretion, potentially increasing or decreasing the burden on public jurisdictions to maintain these roads.

Attitudes, Beliefs, Lifestyles, and Values

General impacts on population subgroups would be the same as for Alternative B.

Alternative E would have impacts on water resources and water resource values that are similar to the impacts of Alternative B and Alternative D (see *Hydrological Resources* section).

Personal Income

Personal income would be the same as described under Alternative B.

Government Revenues

Government revenues would be the same as described under Alternative B.

Oil and Gas Income

Oil and gas income would be about the same as described for Alternative B, although water treatment costs could be greater, thus potentially decreasing the net income to producers.

Taxes

Income Taxes

Income taxes would the same as described under Alternative B.

Property Taxes

Property taxes would be the same as described under Alternative B.

Natural Resource Taxes

Natural resource taxes would be the same as described under Alternative B.

Other Taxes

Other taxes would be the same as described under Alternative B.

Water Resource Values

Alternative E would have impacts on water resources and water resource values that are similar to the impacts of Alternative B and Alternative D (see discussion in *Hydrological Resources* section). The activities proposed to prevent the degradation of surface and groundwater resources would substantially reduce erosion and surface water quality impacts.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described above for Alternative E. Social and economic impacts would include creation of a limited number of new jobs in the emphasis area and related demographic shifts from people moving to the area. The impact of added employment and population on social conditions on the Crow Reservation would be small. Some new personal and government income would be generated as discussed above. The effect of this new income on the Reservation would depend on a number of factors, including the extent to which Reservation members participate in the off-Reservation jobs or mineral ownership. Compared to other alternatives, oil and gas income could be less, depending on water treatment costs. See the Attitudes, Beliefs, Lifestyles and Values section under this alternative for additional information on social effects to Native Americans.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described above for Alternative E. Social and economic impacts would include creation of a limited number of new jobs in the emphasis area and related demographic shifts from people moving to the area. The impact of added employment and population on social conditions on the Northern Cheyenne Reservation would be small. Some new personal and government income would be generated as discussed above. The effect of this new income on the Reservation would depend on a number of factors, including the extent to which Reservation members participate in the off-Reservation jobs or mineral ownership. Compared to other alternatives, oil and gas income could be less, depending on water treatment costs. See the Attitudes, Beliefs, Lifestyles and Values section under this alternative for additional information on social effects to Native Americans.

Social and economic impacts from CBM development on federal lands would be mitigated as described in the Northern Cheyenne Mitigation Appendix. However, most measures focus on preventing the loss of tribal resources such as CBM water. The BLM would consult with the Tribe where site-specific analysis identifies social or economic impacts on the Reservation.

The Northern Cheyenne Tribe can require their special socioeconomic mitigation measures in tribal leases on the reservation.

Conclusions

Residual impacts would be similar to those for Alternative B, with the exception of the reduced impacts on lifestyles and values and water resource values that would result from the proposed measures to prevent the degradation of water resources.

Cumulative impacts would be somewhat less than for Alternative B, given the greater variety of control measures that would be used to prevent water resource impacts.

Environmental Justice

Environmental Justice *Executive Order 12898 requires the non-discriminatory treatment of minority and low-income populations for projects under the jurisdiction of a federal agency*
Alternative A **No Action (Existing CBM Management)**
• No adverse impacts with the exception of the undetermined Wyoming discharge influence. It is concluded that no adverse human health or environmental effects would be expected to fall disproportionately on minority or low-income populations from this alternative.
Alternative B **CBM Development with Emphasis on Soil, Water, Air, Vegetation, Wildlife and Cultural Resources**
• No adverse human health impacts are foreseen from these environmental changes. The influence of Wyoming's discharge on Montana river's would constitute a potential environmental justice issue if unresolved. No adverse human health or environmental effects would be expected to fall disproportionately on minority or low-income populations from this alternative.
Alternative C **Emphasize CBM Development**
• Same as B except for adverse environmental effects would be expected from downstream water quality changes resulting in limitations to subsistence living styles. These limitations would fall disproportionately on minority or low-income populations from this alternative. Wyoming Discharge issues same as Alternative B.
Alternative D **Encourage CBM Exploration and Development While Maintaining Existing Land Uses**
• No adverse human health or environmental effects would be expected to fall disproportionately on minority or low-income populations from this alternative. Wyoming Discharge issues same as Alternative B.
Alternative E **Preferred CBM Development Alternative**
• No adverse human health or environmental effects would be expected to fall disproportionately on minority or low-income populations from this alternative. • Impacts would be mitigated as described under the Environmental Justice section, Alternative A and by implementation of the Project Plan requirements.

Assumptions

The purpose of this analysis is to report whether high and adverse human health or environmental effects of the proposed alternatives are likely to fall disproportionately on minority or low-income populations. This analysis focuses on the populations that are located within the areas potentially affected by the alternatives. It examines where expected high and adverse impacts, if any, fall relative to minority and

low-income populations. In order to make a finding that a proposed project is inconsistent with the Environmental Justice policy established in Executive Order (EO) 12898 and described in Section 4.10.1.7, two situations must occur at the same time: 1) there must be a minority or low-income population; and 2) that population must receive a disproportionately high and adverse environmental or human health impact.

Two options are considered depending on what the impacts are:

- If adverse impacts are identified in the resource analyses, the individual occurrence potential is analyzed for disproportionate effects on minority and/or low-income populations.
- If no adverse impacts are identified in the resource analyses, then no environmental justice issues would be expected as a result of the alternative. Therefore, it can be concluded that no adverse human health or environmental effects would fall disproportionately on minority or low-income populations. Consequently, none of the impacts of the alternative can be described as having a high and adverse impact in the context of EO 12898. The proposed alternatives are therefore consistent with the policy established in EO 12898.

Impacts from Management Common to All Alternatives

Current management of conventional oil and gas resources does not appear to be disproportionately impact minority populations.

Under management common to all alternatives, the EO and guidance would continue to provide for minority participation in future BLM management decisions.

Impacts From Management Specific to Each Alternative

Alternative A—No Action (Existing CBM Management)

A review of the impact analyses prepared for the existing management alternative did not reveal adverse impacts that warrant further analysis for disproportionate effects to minorities or low-income populations. The exception is the potential impact of CBM-produced waters being discharged into the Little Bighorn River and the Tongue River Reservoir from Wyoming CBM activities. See reservation discussions below.

Crow Reservation

The Little Bighorn River, which originates in Wyoming and flows onto the Crow Reservation, could experience impacts to its water quality. The changes in water quality would be dependent upon the terms of the Final Water Quality Agreement signed between Montana and Wyoming. The current interim agreement does not address the Little Bighorn watershed. Impacts could range from a negligible effect to a modest increase in SAR, Total Dissolved Solids (TDS), EC, and bicarbonate. If the agreement allows for some CBM-produced water to be discharged into the Little Bighorn River, the resulting downstream water would increase SAR, EC, TDS, and bicarbonate, thus the tribe's beneficial use of that water may be diminished as well as the tribe's ability to market their water as a commodity. No health effects are foreseen from the change in water quality or the consumption of downstream fish present in the Little Bighorn River.

Northern Cheyenne Reservation

Impacts to the Northern Cheyenne's Water Right in the Tongue River Reservoir would be the result of Wyoming allowing CBM-produced waters to be discharged into the Tongue River, altering the water quality of the reservoir. The range of water quality changes would be dependent upon the Final Water Quality Agreement between Montana and Wyoming. Current policy in Wyoming is that there would be not discharge of CBM-produced water into the Tongue River. The scenarios for possible impact ranges are described in detail in the Hydrological Resources section of this chapter. Worth mentioning though, is that even a slight change in water quality to the reservoir could impact the Northern Cheyenne's ability to market their water as a commodity and reduce their own beneficial uses.

Conclusion

The potential impacts to the surface water concerns of both tribes would be somewhat alleviated by their participation in the state-to-state discussions regarding the Water Quality Agreement. If either tribe were to obtain self-governance over their water quality, they could act with the authority of a state and set their own water quality or non-degradation standards and negotiate with Wyoming for an altered agreement more in line with their specific needs and concerns. Currently, the Northern Cheyenne are working with the EPA to adopt draft water quality standards and obtain primacy for their surface water.

Alternative B—Emphasize Soil, Water, Air, Vegetation, Wildlife, and Cultural Resources

A review of the resource analyses conducted for Alternative B identifies the following impacts that warrant further review for disproportionate effects on minority or low-income populations. The impacts included in this evaluation are the drawdown of groundwater; air quality changes; and changes to vegetation and soils.

Groundwater Drawdown

CBM production in Montana would result in the depletion of an estimated 23 percent (ALL 2001b) of the groundwater resources in the productive coal seams beneath Montana's Powder River Basin watersheds. This drawdown would be basinwide and correspond to the geographical distribution of production wells. The occurrence potential is not localized and would not impact segregated portions of the population; the impact would be felt evenly across the region. Furthermore, the drawdown has the potential to reduce surface water flows in some drainages depending on specific site conditions. The availability of groundwater is important, as many rural families depend on the supply of groundwater for their household and ranch/agricultural (irrigation) applications.

Air Quality Changes

CBM development in the Powder River Basin would necessitate the construction of many minor emission sources spread out over a very large area. The air quality modeling shows potential air quality impacts at downwind mandatory Federal PSD Class I areas, and that other "sensitive receptors" would exceed the PSD Class I NO_2 increment; cause nitrate and sulfate atmospheric deposition (and their related impacts) in sensitive lakes; and cause perceptible visibility impacts (regional haze). Additionally, there is the potential for the NAAQS to be exceeded for NOx in the Spring Creek Coal Mine area. However, it should be noted that these findings are representative of the maximum potential air quality impacts.

Generally, the potential changes in air quality from development would be within acceptable limits, widespread and distributed across the region. The impacts associated with the dispersion of air pollutants across the region would not be disproportionately distributed upon any minority or low-income groups.

Crow Reservation

Under this alternative, a 2-mile buffer zone would be enforced on federal mineral development around the reservation to restrict development of minerals adjacent to these boundaries. This buffer zone would delay some of the groundwater drawdown impact associated with federal pumping but would not prevent state and private mineral estates from being developed adjacent to the reservation. Therefore, drawdown could affect Indian populations within the Crow Reservation adjacent to off-reservation development.

The Crow tribal government derives some of its income from operator lease fees: ranchers and irrigators operating both on private and reservation lands. If these operators were to experience a reduction in available groundwater that impacted their operations and the Crow Tribe subsequently had to reduce their changed the fees, the tribe would lose a portion of their income. Trust agencies might be needed to resolve conflicts. The form of resolution most desirable would be the replacement of water resources and the according adjustment in fees. If the replacement of water resources could not be achieved because of site-specific conditions or other variables, the loss in potential income generation from reduced fees and limited new fee opportunities would have to be made up for or this could be an environmental justice issue.

Northern Cheyenne Reservation

The Northern Cheyenne Tribe would experience similar groundwater drawdown and potential operator lease fee issues as discussed under the Crow Reservation section above.

As described under the above Air Quality Changes section, the air quality modeling shows potential air quality impacts at downwind mandatory Federal PSD Class I areas and the Northern Cheyenne's PSD Class I area, as well as causing a small increase in perceptible visibility impacts (regional haze). However, these findings are representative of the maximum potential air quality impacts.

Conclusions

If the Northern Cheyenne and Crow tribes elected to develop their CBM resources the federal buffer zone would not be used to limit the effect on the reservation. An additional percentage of drawdown would be experienced across the basin watersheds from the Northern Cheyenne and Crow tribal developments (see Hydrological Resources section for details). If the tribe's CBM resources were drilled to the degree estimated in the RFFA (4,000 wells for each

reservation), the depletion of the coal seam aquifer groundwater resource could increase across the region and cause a hardship on numerous low-income and minority populations, which are prevalent throughout the area. However, water well and spring mitigation agreements required by the MBOGC, BLM, and TLMD would provide alternate sources of water due to groundwater lost to the drawdown of resources within the coal seam aquifers. Drawdown in non-producing coal seams aquifers is not anticipated. Replacement may not be possible in some areas with concentrated CBM production. This represents a possible environmental justice issue if the non-replacement areas are adjacent to reservation boundaries and no suitable water is available for mitigation.

No adverse human health impacts are foreseen from these environmental changes. The influence of Wyoming's discharge on Montana rivers would constitute a potential environmental justice issue if unresolved. It is concluded that no adverse human health or environmental effects would be expected to fall disproportionately on minority or low-income populations from this alternative.

Alternative C—Emphasize CBM Development

The resource analyses performed for Alternative C indicate that groundwater drawdown, and changes to the surface water quality and the subsequent impacts on vegetation, wildlife, and aquatic resources would have effects that warrant further review for disproportionate effects on minority or low-income populations.

Groundwater Drawdown

The drawdown of groundwater within the Powder River Basin watersheds would have greater effects than described under Alternative B. Without the federal development buffer zone around Indian reservations, drawdown effects could be amplified and appear sooner on reservation properties than under Alternative B.

Surface Water Quality

Under Alternative C, the quality and quantity of surface waters in the Powder River Basin watersheds could be altered depending on the outcome of the statewide water quality standards. The MDEQ is in the process of setting statewide water quality standards that would likely include the framework for managing surface discharge of CBM-produced water throughout the state. The watersheds would most likely experience increases in SAR values, sedimentation, TDS, and a marginal increase in base flow as described in the Hydrological Resources section of this chapter. Based on SAR values, the addition of untreated CBM-produced waters with high SAR values under the least restrictive extreme criteria would not exceed an SAR value of 12. High-quality watersheds in the CBM emphasis area would have adequate assimilative capacity to accept expected discharges from full-scale development of CBM. All other watersheds should only experience a slight increase in SAR, which would remain below the suggested not to exceed a value of 3 for some soils and possibly as high as 12 for others.

It is assumed that the sodium content of produced CBM water is the target contaminant that determines the usefulness of the water for crop irrigation. Irrigation uses the majority of water resources in those watersheds thought to have the greatest potential for CBM development. Sodium causes osmotic stress to plants and destroys the texture of clayey soils; these combined effects make sodium content, and especially SAR, a point of emphasis when gauging impacts to water resources from CBM water. Other parameters such as TDS, nitrogen, and barium concentration may be locally important in determining restrictions to beneficial use. It is assumed that discharge to high-quality watersheds would be limited during the irrigation season and managed on a flow-based discharge scenario. Under these circumstances, high-quality watersheds in the CBM emphasis area would have sufficient capacity to meet the current irrigation needs. Flow-based discharge would however, require additional storage of produced water during the irrigation season for later discharge when stream flows are less sensitive to being impacted by produced water discharges.

The consequential downstream effects of increased SAR and base flow would result in the erosion of riparian areas along rivers, the reduction of both vegetation and wildlife habitat, and the impairment of fish populations. These consequential effects are mentioned because of the large number of Native Americans who have a traditional reliance on the natural agriculture for sacred plants used in medicines and for their hunting and fishing way of life. If these combined water quality impacts are realized, there could be a disproportionate effect felt by the Native Americans as it reduces their ability to gather sacred plants and limit their hunting and fishing opportunities. A large percentage of the population in Big Horn (61 percent) and Rosebud (33 percent) counties are Native Americans and constitutes a sizeable minority population within the CBM emphasis area.

Crow Reservation

Impacts on the Crow Reservation are expected to be similar to impacts projected for the CBM emphasis area. The reservation can expect impacts to Bighorn, Little Bighorn, Rosebud, and Squirrel Creek watersheds, such as increased flow volume, changes to water quality parameters, including SAR, EC, and bicarbonate. The Crow Tribe could experience drawdown of groundwater in coal seam aquifers from Wyoming and Montana CBM production. The traditional pattern of natural resource consumption would be altered and therefore impacts to sacred plants and hunting and fishing are expected.

Northern Cheyenne

Impacts on the Northern Cheyenne Reservation are expected to be similar to impacts projected for the CBM emphasis area. The Northern Cheyenne Reservation could experience impacts to the Tongue River and Rosebud Creek in the form of increased flow volume and changes to water quality parameters, including SAR, EC, and bicarbonate. The reservation could also experience drawdown of coal seam aquifers from CBM production in the area surrounding the reservation. The traditional pattern of natural resource consumption would be altered and therefore impacts to sacred plants and hunting and fishing are expected.

Conclusions

These surface water quality and quantity effects, when combined with the increases projected from similar current and planned CBM development activities in Wyoming, would further increase the SAR value, base flow, and other potential constituents of concern in the, Powder and Little Powder rivers. The combined decrease in water quality would necessitate the use of flow-based discharge to avoid limiting the resource for use as a source of irrigation. The resulting impacts may still impair tribal government leasing activities. This could create an environmental justice issue to tribes as described under Alternative B.

No adverse human health impacts are foreseen from these environmental changes. The influence of Wyoming's discharge on Montana rivers would constitute a potential environmental justice issue if unresolved. It is concluded that adverse environmental effects could occur from downstream water quality changes, resulting in limitations to subsistence living styles. These limitations would fall disproportionately on minority or low-income populations from this alternative.

Alternative D—Encourage Exploration and Development While Maintaining Existing Land Uses

A review of the resource analyses for Alternative D revealed that similar potential effects would be felt as described under Alternative B for groundwater drawdown and air quality changes and under Alternative C for surface water quality but at a reduced impact because of water treatment and discharge conveyance. The same trickle-down effects would be experienced under Alternative D as described in Alternative C but, again, at a reduced level because of water treatment.

Crow Reservation

Impacts on the Crow Reservation are expected to be similar to impacts described under Alternative C with the exception of Montana CBM surface water quality impacts. Surface water impacts would be limited to changes due to increased quantity of surface discharge but treatment prior to discharge would reduce impacts to water quality compared to Alternative C. Groundwater impacts would be the same as Alternative B.

Northern Cheyenne

Impacts on the Northern Cheyenne Reservation would be similar to impacts described under Alternative C with the exception of Montana CBM surface water quality impacts. Surface water impacts to the Tongue River and Rosebud Creek would result from increases in quantity of surface discharge but treatment prior to discharge could reduce impacts to water quality. Groundwater impacts would be the same as Alternative C.

Conclusions

The surface water quantity effects, when combined with the increases projected from similar current and planned CBM development activities in Wyoming, would be less than those described in Alternative C because of the treatment of discharge water. Water would be available for irrigators and tribal government leasing activities and would not be impaired. The drawdown of groundwater and subsequent availability would be as described in Alternative B. If the Northern Cheyenne and Crow tribes elected to develop their CBM resources, impacts would occur as described under Alternative B. No adverse human health impacts or environmental effects are foreseen from these management objectives.

Alternative E—Preferred Alternative

The impact analyses for Alternative E shows that impacts on surface water quality would be slightly altered; however, downstream uses would not be diminished nor would the State's water quality standards be exceeded. Alternative E stresses the beneficial uses of produced water from CBM wells and requires a Water Management Plan be developed that demonstrates how an operator can discharge without degrading the surface water quality before any discharge can occur. Similar potential effects would occur as described under Alternative B for groundwater drawdown and air quality changes.

Crow Reservation

Impacts on the Crow Reservation are expected to be similar to impacts projected for the region under Alternative E with the exception of groundwater impacts. Operators are required to conduct site-specific hydrological studies prior to APD approval. If the site-specific studies determine there would be an effect to Reservation groundwater, the operator must develop and apply measures to prevent the impact of groundwater withdrawal and monitor the effectiveness of such measures. These measures would be approved by BLM in consultation with the Tribe. Furthermore, operators must modify federal CBM production if production is resulting in an effect on groundwater or CBM on the Reservation. BLM requirements could include reducing production rates, shutting in the well or wells, or providing compensation to the Tribe. The operator must correct the impact of groundwater withdrawal prior to resuming full production.

For lands under the jurisdiction of the State, the operator would be required to follow recommendations in the Technical Advisory Committee's (TAC) guidance document for meeting the requirements of the MBOGC Order No. 99-99. The order requires an evaluation of pre-development groundwater conditions, plus monitoring and evaluations, including procedures for monitoring and reporting the effects of CBM development on water users. Based on the implementation of these measures Tribal groundwater resources would be protected and potential impacts eliminated.

Northern Cheyenne

Impacts on the Northern Cheyenne Reservation are expected to be similar to impacts projected for the region under Alternative E with the exception of groundwater impacts. Operators are required to conduct site-specific hydrological studies prior to APD approval. If the site-specific studies determine there would be an effect to Reservation groundwater, the operator must develop and apply measures to prevent the impact of groundwater withdrawal and monitor the effectiveness of such measures. These measures would be approved by BLM in consultation with the Tribe. Furthermore, operators must modify federal CBM production if monitoring shows production is resulting in an effect to groundwater or CBM on the Reservation. BLM requirements could include reducing production rates, shutting in the well or wells, or providing compensation to the Tribe. The operator must correct the impact of groundwater withdrawal prior to resuming full production.

For lands under the jurisdiction of the State, the operator would be required to follow recommendations in the TAC guidance document for meeting the requirements of the MBOGC Order No. 99-99. The order requires an evaluation of pre-development groundwater conditions, plus monitoring and evaluations, including procedures for monitoring and reporting the effects of CBM development on water users. Based on the implementation of these measures, Tribal groundwater resources would be protected and potential impacts eliminated.

Surface water impacts on the Tongue River and Rosebud Creek would also be reduced. The surface water quality in these two waterbodies would be slightly altered; however, downstream uses would not be diminished nor would the proposed Northern Cheyenne water quality standards be exceeded.

With regards to air quality, operators would be required to provide the information necessary for BLM to conduct an analysis of air quality impacts for all relevant parameters when submitting their exploration APDs or field development project plans. BLM would use the information to determine the individual and cumulative impact on the Reservations' air quality, disclose the analysis results in the appropriate NEPA document, and consult with the Tribes when the analysis shows impacts from a specific drilling or development proposal.

Approval of exploration APDs and field development plans, and the air quality new source review process would include conditions to prevent violations of applicable air quality laws, regulations, and standards. Mitigating measures may include surfacing roads and well locations, applying dust suppressants, requiring operators to develop and enforce speed limits on project roads, minimizing construction of roads, requiring use of natural gas-fired and electric compressors, and optimizing the number of wells connected to one compressor.

Operators near the Reservation may be required to restrict the timing or location of CBM development if monitoring or modeling by the air quality regulatory authority finds their CBM development is causing or threatening to cause non-compliance with applicable local, state, tribal, and federal air quality laws, regulations, standards, and implementation plans.

To protect important hunting, fishing, and plant gathering sites, the BLM would require operators in the area east of the Tongue River between Ashland and Birney to inventory BLM lands for traditional plant gathering sites near the proposed drilling locations. APD approvals may include avoidance or timing restrictions to prevent impacts to identified important hunting, fishing, and plant gathering sites depending on the developments' location. These measures would prevent potential impacts to subsistence living methods for tribal members. Migratory paths traditionally used by game to cross the Northern Cheyenne Reservation would be monitored as part of the Wildlife Monitoring and Protection Plan. If these impacts to migration routes result in a reduction of available game measures would be developed in consultation with the Tribe to provide for wildlife migration.

Conclusions

These surface water quality and quantity effects, when combined with the increases projected from similar current and planned CBM development activities in Wyoming, would be less then those described in Alternative C. Water would be available for irrigators and tribal government water leasing activities would not be impaired. The groundwater would be protected as described in the Northern Cheyenne Mitigation Appendix.

If the Northern Cheyenne and Crow tribes elected to develop their CBM resources, impacts as described under Alternative B above would occur.

No adverse human health or environmental effects are anticipated from this alternative.

Soils

Soils *Montana has a wide mix of geologic parent material, which produces a vast array of different soil types*
Alternative A **No Action (Existing CBM Management)**
• There would be minor occurrences of soil erosion, runoff, and sedimentation, mostly during construction activities. • Approximately 1,500 acres would be disturbed short term during CBM exploration and construction activities. • 500 acres would be disturbed longer term during production, with a majority of the land reclaimed after production is ceased.
Alternative B **CBM Development with Emphasis on Soil, Water, Air, Vegetation, Wildlife and Cultural Resources**
• CBM development would result in 55,400 acres being disturbed. • 32,950 acres would be disturbed longer term during production, with a majority of the land reclaimed after production is ceased. • No impacts would occur to soils from CBM waters.
Alternative C **Emphasize CBM Development**
• CBM development activities would disturb 70,000 acres. • Surface discharge and irrigation of produced water could result in detrimental impacts to soils.
Alternative D **Encourage CBM Exploration and Development While Maintaining Existing Land Uses**
• Impacts would be similar to Alternative B with the exception that produced water would be treated prior to discharge onto the surface and not injected. • More water would be available for irrigation of agricultural land.
Alternative E **Preferred CBM Development Alternative**
• Impacts would be similar to Alternative B. There would be a slight increase in the level of disturbance due to the increased use of impoundments to contain produced water. • Produced water would be available for beneficial use, including irrigation.

Assumptions

Surface disturbance assumptions are detailed in the *Analysis Assumptions and Guidelines* section of this chapter. This analysis is focused on the CBM emphasis area, but can be used by inference on similar areas in Montana. A more detailed discussion of soils is presented in the *Soils Technical Report* (ALL 2001a).

Impacts From Management Common to All Alternatives

Impacts on soils would occur from various activities during the exploration, construction, operation, and abandonment of conventional oil and gas wells developed resulting in a loss of either soil resources or soil productivity. These impacts would include soil compaction under disturbed areas such as well sites and lease access roads, soil erosion in disturbed areas, and chemical impacts from spills of liquids. Some impacts would be unavoidable, such as those resulting from the construction of well sites. Other impacts would be mitigated by standard oil field practices, such as the use of berms around production facilities. Short-term impacts would occur typically during construction phases, including reclamation of construction sites.

Soils disturbed by the building of access roads, drill pads, and pipelines would be prone to accelerated erosion because of the removal of protective vegetation and litter cover during construction activities. This protective cover would bind the soil, provide desirable surface texture for infiltration of water and air, and protect the surface from water and wind erosion. Accelerated soil erosion would occur during the production phase in high traffic areas of the well pad or along access roads or in portions of the well pad that have not been properly graded. In areas where soils have high to severe erosion potential and are unstabilized, disturbance would result in accelerated erosion to the extent that damage to facilities and roadways may occur. Wind and water erosion on bare soil surfaces would cause more sedimentation in streams from runoff following rainfall or snowmelt.

Impacts would be greatest on shallow soils of low productivity and on soils on moderately sloping to steep landscapes. Project activities would have minimal effect on slope stability because surface disturbance on slopes in excess of 30 percent would be avoided where possible. Where such disturbances cannot be avoided, mitigative measures required by MBOGC and BLM through the APD authorization process would be implemented to reduce erosion and protect watershed resources. BLM and TLMD lease stipulations would also be used to mitigate soil erosion. Eastern Montana suffers from excessive wind erosion primarily from dry soil, sparse vegetative cover, and erodible soils.

Drilling activity-especially equipment transport-would cause soil compaction. The degree of compaction would be influenced by soil texture, moisture content, organic matter, and soil structure. Soils with a mixture

of sand, silt, and clay compacts more than a soil with more uniform particle size. Coarse-textured sandy soils generally would be more compactable than fine-grained soils. Soil moisture would be the most critical factor in compaction. At field capacity, which is the amount of soil moisture remaining after a soil mass is saturated and allowed to drain freely for 24 hours, sufficient water remains in the pores to provide particle-to-particle lubrication and maximum compaction potential under load. Thus, moist but not wet soils would be most susceptible to compaction.

Organic matter such as roots and humus would help reduce soil compaction. In general, the greater the organic matter content, the less compaction. Compaction would severely affect plant growth by inhibiting root penetration, limiting oxygen and carbon dioxide exchange between the root zone and the atmosphere, and severely limiting the rate of water infiltration into the soil. Compaction of soils would inhibit reclamation and natural revegetation of disturbed areas. Loss of topsoil and a decrease in soil productivity from soil layer mixing and compaction would impact the natural vegetation supported in the area, which in turn may affect forage and habitat for wildlife and livestock. The use of off-road vehicles and heavy equipment would cause soil compaction, which will lead to increased surface runoff and subsequent erosion. Effects will be most severe when off-road vehicles and heavy equipment are used during moist and wet soils conditions.

With development, the potential for impacts to soil from drilling and produced fluids would increase. Soil contamination from conventional oil and gas development in Montana would result mainly from leaking and improperly reclaimed reserve/brine pits. Produced hydrocarbons and fuel spills would occasionally cause impacts. Spills generally would not be large and the materials would be relatively immobile. Toxic and saline concentrations from the spilled fluids would be capable of sterilizing the soil.

Construction disturbances from conventional oil and gas production would lead to the disturbance of approximately 12,650 acres (9,817.5 acres of BLM lands and 2,832.5 acres of state lands) during the next 20 years. Revegetating parts of the well pads during production would reduce the area of disturbance to 4,600 acres. Most of these acres would be remediated after the hydrocarbons have been produced.

The area would be reclaimed as prescribed by an approved reclamation plan that includes revegetation to reduce soil erosion. Most soil disturbances and related erosion would begin to be mitigated within 20 to 25 days after drilling the well. Exceptions would be sites with severe characteristics (slope and physical and chemical nature of the soils) or sites where saline water spills or site contamination have occurred. These sites may take longer to remediate because special erosion control seeding or remediation measures may be necessary to achieve successful reclamation. These impacts may result in a loss of either soil resources or soil productivity.

Saline water would have a more persistent and detrimental effect on soil productivity. There would be some loss of soil through erosion as a result of surface disturbance, but this would be minimized with an approved surface use plan.

Additional disturbances would occur from coal mining in the CBM emphasis area, which is estimated at a total of 49,500 acres.

Prime Farmland

If prime farmland exists on federal or state surface where CBM development is proposed, the same type of reclamation plan is developed for it as with all such proposals. A difference would be that more topsoil probably would be available for reclamation purposes on a prime farmland site and would be identified in the reclamation plan prior to development.

If the site proposed for development were private surface, then the reclamation plan would be developed in consultation with and according to the wishes of the private landowner. Most likely, the reclamation plan on Federal versus state and private surface would be very similar.

No prime farmlands are known to exist on the federal surface. Privately owned prime farmlands over federal and state leases that are impacted by roads or site development would be reclaimed in accordance with consultation with the private surface owner. This situation would be same for all alternatives.

Impacts From Management Specific to Each Alternative

Alternative A—No Action (Existing CBM Management)

Impacts on soils may occur from various activities during the exploration, construction, operation, and abandonment of CBM wells developed for the project and may result in a loss of either soil resources or soil productivity. The primary concerns include increased soil erosion, loss of topsoil, mixing of soil horizons, compaction, and contamination of soils from various

pollutants. These impacts may result in a loss of either soil resources or soil productivity.

Under this alternative, all CBM water on BLM-administered land would be contained or beneficially used at the well site, while all CBM water on private lands would be discharged under the existing MPDES permit into the Tongue River (up to 1,600 gpm), impounded, or used for dust control at on-site coal mines.

Exploration

Under Alternative A for BLM lands, approximately 400 acres would be disturbed for exploratory wells. On state and private lands, approximately 275 acres would be disturbed during exploration. All produced CBM water during exploration will be contained; therefore, there would be no impacts to soils caused by high saline/sodium water applications.

Production

There will be no CBM production on BLM lands and therefore no impacts from production. Only state and private lands will have CBM production. During the construction of the well sites, access roads, utilities, and other facilities, 812 acres of soils will be disturbed. Revegetating parts of the well pads during production would reduce the state and private soil disturbances to 500 acres. Production water may be discharged to surface waters in accordance with the existing MPDES Discharge Permit that allows discharge up to the rate of 1,600 gpm into the Tongue River. This small increase in flow volume is not considered sufficient to cause added erosion to stream banks or streambeds. Produced water may also be used beneficially by industry and landowners, or stored in impoundments onsite. If the quality of the water were acceptable (not too high in SAR or salinity), there would be little or no additional impacts to soils from land application. If the quality of land-applied water were detrimental, further mitigation measures would need to be implemented to reduce the impacts to soils (ALL 2001a).

Abandonment

After reclaiming the exploratory wells, there will be 500 acres of soil disturbed long-term-all on state and private lands. The area will be reclaimed as prescribed by an approved reclamation plan including revegetation to reduce soil erosion. Soils would be stabilized by vegetative cover and erosion eliminated within 2 to 5 years following the beginning of reclamation. Exceptions may be sites with severe characteristics (slope and physical and chemical nature of the soils) or sites where saline water spills or site contamination have occurred. These sites may take longer to remediate because special erosion control seeding or remediation measures may be necessary to achieve successful reclamation.

There may be some irretrievable loss of soil through erosion as a result of surface disturbance, but this can be minimized with a well-developed and approved surface use plan. Soil beneath unlined surface impoundments would also require extensive reclamation because of accumulation of sodium during infiltration of water. The soils structure could be damaged severely, plant growth would be minimal, and accumulation of salt in the soils would likely lead to the soil being removed and disposed.

Crow Reservation

There would be no impacts to the soils on the Crow Reservation from regional CBM development.

Northern Cheyenne Reservation

There would be no impacts on the Northern Cheyenne Reservation soils from regional CBM development.

Conclusion

During the next 20 years, disturbances from limited CBM development and exploration, conventional oil and gas development, coal mining, and other projects considered under the cumulative effects analysis would result in the disturbance of about 38,500 acres of soil. These disturbances would be reduced to about 30,500 acres during the production phase of CBM, conventional oil and gas activities, and coal mining.

After production ceases and lands used for production and mining are abandoned, most land can be returned to production (excluding permanent roads and facilities). There would be minimal unavoidable, irreversible, and irretrievable impacts to soils. There would be a temporary increase in soil erosion, runoff, and sedimentation, mostly during construction activities. If the qualities of land-applied or impounded waters were acceptable, there would be little or no impacts to soils; but if water quality is detrimental, additional mitigation measures would need to be implemented.

Alternative B—Emphasize Soil, Water, Air, Vegetation, Wildlife, and Cultural Resources

Impacts to soils would be reduced under this alternative by requiring transportation corridors; using a single trench for utilities and piping; using multiple

completions per well bore and directional drilling; using temporary tank storage and injection of all produced CBM water; and rehabilitating new roads at the end of the well lifetime. All of these would help to minimize the area of surface disturbances, which would be up to a 35 percent or higher reduction in soil disturbances.

Exploration

Under this alternative, approximately 850 acres of BLM lands would be disturbed for exploratory wells. On state and private lands, approximately 1,000 acres would be disturbed during exploration. All produced CBM water during exploration will be contained; therefore, there would be no impacts to soils caused by high saline/sodium water applications. Losses from exploration would be mostly temporary and would be reclaimed after exploration activities cease.

Production

During the construction of the well sites, access roads, utilities, and other facilities, 25,600 acres of BLM soils and 29,750 acres of state and private soils will be disturbed. Revegetating parts of the well pads during production would reduce the BLM soil disturbances to 15,250 acres and state and private soil disturbances to 17,700 acres. Production water will be injected; therefore, no impacts will be made to soils from CBM waters.

Abandonment

Reclaiming all of the exploratory wells would provide vegetation cover to 1,850 acres of disturbed soils. Additional reclamation activities at the production wells and utility right-of-ways (ROWs) would further establish vegetation cover to these previously disturbed soils. The disturbed areas would be reclaimed as prescribed by an approved reclamation plan including revegetation to reduce soil erosion. Soils would be recovered and erosion halted within 2 to 5 years, following the beginning of reclamation.. Exceptions may be sites with severe characteristics (slope and physical and chemical nature of the soils). There may be some irretrievable loss of soil through erosion as a result of surface disturbance, but this can be minimized with a well-developed and approved surface use plan.

Crow Reservation

There are no Tribal sponsored CBM developments anticipated for the reservation; however, there is the possibility of on-reservation fee or private lands being developed in small pockets. These small on-reservation developments are expected to impact the soils in proximity to the wells and associate infrastructure in a similar fashion as describe above in general for Alternative B.

Northern Cheyenne Reservation

There would be no impacts on the Northern Cheyenne Reservation soils from regional CBM development. It is not anticipated that there would be any Tribal sponsored CBM development on the reservation nor areas of fee or private development.

Conclusion

During the next 20 years, disturbances from CBM development, conventional oil and gas development, coal mining, and other projects considered under the cumulative effects analysis would result in the disturbance of about 102,300 acres of soil. These disturbances would be reduced to about 81,000 acres during the production phase of CBM, conventional oil and gas activities, and coal mining. After production ceases and lands used for production and mining are abandoned, most land can be returned to production (excluding permanent roads and facilities). There would be minimal unavoidable, irreversible and irretrievable impacts to soils. There would be a temporary increase in soil erosion, runoff, and sedimentation, mostly during construction activities.

Development of the Crow and Northern Cheyenne reservations would disturb an initial 24,200 acres or 12,100 acres per reservation. Following the same reclamation measures as commercial CBM development, the disturbances would be reduced by nearly 10,000 acres. Each reservation would have a residual 7,200 acres of disturbed soils around well pads, access roads, utility corridors, and water management facilities.

Alternative C—Emphasize CBM Development

Under this alternative, impacts on soils would be similar to Alternative B with the following exceptions:

- Untreated CBM discharge water could be used for land application
- The discharge of produced water to the ground surface would increase erosion
- There would be a 35 percent increase in impacted soils due to specific management practices for transportation routes

The long-term impacts of using CBM water or diluted discharge water for agricultural purposes include crop effects, farming practice changes, irrigation management, and direct effects to soils. Based on the generally fine texture of the surface soils (clayey) in the emphasis area, much of the soil would likely be susceptible to increasing sodicity when irrigated or land applied with water having a high SAR (generally greater than 3 for some soils and greater than 12 for others). If sodic water is applied to these soils, the probability of soil dispersion (deflocculation) is high, causing infiltration and drainage decreases. The long-term consequence is an anaerobic, waterlogged, saline/sodic soil, which would be difficult to reclaim. Those soils with a coarser texture (sandy to loamy) and good internal drainage will be the least susceptible to increasing sodicity and salinity.

Dispersed soil would also be subject to accelerated erosion leading to gullying, increased sedimentation, and harm to riparian vegetation and aquatic habitats. The native species composition in these effected areas also will change. CBM water discharge will have the cumulative effect of encouraging the establishment and proliferation of non-native and noxious weed species. As noted in the *Soils Technical Report* (ALL 2001a), there are fewer irrigated than non-irrigated acres along the Tongue and Powder Rivers, which, based on the RFD, is where a majority of the potential CBM activity would reside. However, if adequate water and suitable agricultural soils were available in areas adjacent to production, more irrigated land would be available for production and use.

The use of high salinity/sodium CBM water may have long-term effects on crops, limiting crops to those that are more salt tolerant. Additional irrigation water would be required for leaching to ensure salts are moved out of the root zone. Increasing the frequency of irrigation may also need to be implemented to maintain soil water content and to decrease the effects of applying saline water (lower water-holding capacity and higher salinity levels). These increases in irrigation water amounts would lead to producers having to file for additional water rights or finding other sources of lower salinity water for leaching, as well as a potential for more saline seeps in areas irrigated with CBM water. The *Soils Technical Report* (ALL 2001a) discusses the impacts of discharging CBM waters to soils in more detail.

Exploration

Under this alternative, impacts on soils would be similar to Alternative B, except water generated by testing CBM wells could be discharged to surface waters and the land surface-with impacts as discussed above.

Production

Under this alternative, impacts on soils would be similar to Alternative B, except untreated water generated during production could be discharged to surface water with appropriate permits and to the land surface at the well pad. Impacts of land application of CBM waters are discussed above.

Abandonment

Under this alternative, impacts on soils would be similar to Alternative B. Roads would be rehabilitated and closed. The use of unlined impoundments would have impacts similar to those mentioned in Alternative A.

Crow Reservation

The Crow Reservation would not experience impacts to soils being irrigated with waters from the Bighorn or Little Bighorn Rivers. Impacts associated with on-reservation fee lands would be similar to those described in general for Alternative B. In addition, impacts associated with direct discharge practices as described for Alternative C would be expected for these wells.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be expected to soils being irrigated with waters from the Tongue River and Rosebud Creek. Since these waterbodies would experience increases in their SAR and EC values, it is conceivable that Tribal irrigators would also experience the types of soil impacts described in general for Alternative C. Soils impacts from Tribal sponsored development on the reservation are not anticipated for this alternative.

Conclusion

Cumulative impacts would be similar to Alternative B, except that the surface disturbances would increase by up to 35 percent and surface discharge and irrigation of produced water would increase detrimental impacts to soils. Saline water has a more persistent and detrimental effect on soil productivity, especially when immediate mitigative measures are not followed for cleanup. Cumulative disturbances from all regional projects would result in the disruption of about 134,750 short-term acres of soil. These disturbances would be reduced to about 102,300 acres during the

production phase of CBM, conventional oil and gas activities, and coal mining.

One advantageous side effect would be that more water would be available for irrigation if acceptable agricultural land is available, but if acceptable qualities of water are not used, there could be an increased detrimental impact on additional soils.

Soil disturbance levels on the Crow and Northern Cheyenne Reservations would be similar to those discussed in the Conclusions section of Alternative B, (12,100 – 7,200 acres); however, they are expected to be somewhat increased do to the surface discharge of production water.

Alternative D—Encourage Exploration and Development While Maintaining Existing Land Uses

Under this alternative, impacts on soils would be similar to Alternative B except that produced water would be treated prior to discharge onto the surface or for irrigation, and not injected, which would reduce the detrimental impacts caused by application of high-SAR water to soils.

Exploration

Under this alternative, impacts on soils would be similar to Alternative B, except that water generated by testing CBM wells would be treated prior to discharge to surface waters and the land surface (instead of injection), which lessens the impacts caused by application of high-SAR water to soils.

Production

Under this alternative, impacts on soils would be similar to Alternative B, except water generated during production would be treated prior to discharge to the land surface and to surface water-with appropriate permits. Impacts of the land application of CBM waters are discussed above.

Abandonment

Under this alternative, impacts on soils would be similar to Alternative B. Roads would remain open or closed at surface owner's discretion. The use of unlined impoundments would have impacts similar to those mentioned in Alternative A.

Crow Reservation

The only soils impacted on the Crow Reservation would be from on-reservation fee developments similar to those previously described in Alternative B.

Northern Cheyenne Reservation

There would be no impacts to soils on the Northern Cheyenne Reservation from regional CBM development. Lands irrigated with waters from either Rosebud Creek or the Tongue River are not expected to be impacted, since production water will be treated prior to discharge.

Conclusion

Cumulative impacts would be similar to Alternative B with the exception that produced water would be treated prior to discharge onto the surface and not injected, which would reduce the detrimental impacts caused by application of high-SAR water to soils.

Soils disturbance levels on the Crow and Northern Cheyenne Reservations would be similar to those discussed in the Conclusions section of Alternative B, (12,100 – 7,200 acres).

Alternative E—Preferred Alternative

Under this alternative, impacts on soils would be similar to Alternative B except that produced water would be managed per a site-specific Water Management Plan with first priority being beneficial use of produced water; impoundments designed to minimize or mitigated impacts to soil, water and vegetation; an option for injection of CBM water; and no degradation of a watershed. All of these factors would reduce the detrimental impacts caused by application of high-SAR water to soils. There would be a 35 percent increase in impacted soils over alternatives B and D due to specific management practices for transportation routes-this percent will vary depending on site-specific Project Plans for ROWs agreed upon with the surface owners.

Exploration

Under this alternative, impacts on soils would be similar to Alternative B, except that water generated by testing CBM wells would not be allowed to degrade the watershed, which lessens the impacts caused by application of high-SAR water to soils.

Production

Under this alternative, impacts on soils would be similar to Alternative B, except water generated during production would be beneficially used, stored in impoundments, or discharged without impacts to the watershed. Impacts of the land application of CBM waters are discussed above.

Abandonment

Under this alternative, impacts on soils would be similar to Alternative B. Roads would remain open or closed at surface owner's discretion. The use of unlined impoundments would have impacts similar to those mentioned in Alternative A.

Crow Reservation

The Crow Reservation would not experience impacts to soils being irrigated with waters from the Bighorn or Little Bighorn Rivers. Impacts associated with on-reservation fee lands would be similar to those described in general for Alternative B.

Northern Cheyenne Reservation

There would be no impacts to soils on the Northern Cheyenne Reservation from regional CBM development. Lands irrigated with waters from either Rosebud Creek or the Tongue River are not expected to be impacted, since only slight alterations in surface water quality are anticipated.

Conclusion

Cumulative impacts would be similar to Alternative B with the exception that produced water would be managed per a site-specific Water Management Plan that would be geared toward minimizing impacts to soil, water and vegetation, and surface owners would have more input in the Project Plan for the transportation corridors. Cumulative disturbances from all regional projects would result in the disruption of about 132,000 short-term acres of soil. These disturbances would be reduced to about 92,200 acres during the production phase of CBM, conventional oil and gas activities, and coal mining. Soils disturbance levels on the Crow and Northern Cheyenne Reservations would be similar to those discussed in the Conclusions section of Alternative B, (12,100 – 7,200 acres). It is anticipated the Tribes would manage or require their produced water to be managed in a similar manner to what will be required of off-reservation commercial CBM developers. With this assumption no additional impacts to reservation soils are anticipated from on-reservation development.

Solid and Hazardous Waste

Solid and Hazardous Wastes *Solid and hazardous wastes are under the jurisdiction of the MDEQ for RCRA wastes, MBOGC for RCRA exempt wastes, and the EPA for wastes generated on tribal lands*
Alternative A **No Action (Existing CBM Management)**
• Typical solid waste refuse can be disposed of in local landfills. • Drilling mud and cuttings can be disposed of onsite with the landowner's permission. • Minor impacts would also occur from the use of pesticides and herbicides during access and construction activities
Alternatives B, C, D, and E
• Impacts for Alternative B, C, D, and E would include increased quantities of waste requiring onsite disposal or transport to commercial landfills. • Oil and gas developers are responsible for any damages to property, real or personal, resulting from the lack of ordinary care during operations. Operators are required to maintain SPCC plans and immediately remove and spilled or unused non-exempt wastes from the sites. • No long term impacts to private, state or federal lands would occur from waste products associated with CBM development.

Assumptions

All wastes generated by oil and gas operations including CBM that are Resource Conservation and Recovery Act of 1976 (RCRA)-classified wastes, such as paint wastes or RCRA-exempt wastes such as drilling wastes, would be disposed of in accordance with regulations. Any release of a hazardous material would be reported in a timely manner to the relevant agency or to the BLM via a Report of Undesirable Event (NTL-3A). Any release of a CERCLA substance would be reported in accordance with regulations.

Impacts From Management Common to All Alternatives

Typical solid waste refuse would be generated by oil and gas drilling operations and can be disposed of in local landfills. The largest volume of waste generated from drilling activities would be from the drilling mud and cuttings generated. These drilling wastes would be exempt from RCRA and are considered non-hazardous. Drilling mud containing less than 15,000 mg/l TDS can be disposed of on-site with the landowner's permission. The amount of waste generated should not exasperate the landfills in the area. Other impacts would result from spills of waste during maintenance activities, including waste oil from generators, paint waste from construction activities and other solid wastes from construction activities. Impacts would also occur from the use of pesticides and herbicides during access and construction activities.

Impacts From Management Specific to Each Alternative

Alternative A—No Action (Existing CBM Management)

Impacts from Alternative A would be similar to the impacts described in the previous *Impacts From Management Common to All Alternatives* section . The solid and hazardous waste generated during CBM exploration, production, and abandonment would be similar to conventional oil and gas. The drilling muds would be of lesser quantity because of the shallow drilling depths for CBM wells compared to conventional oil and gas.

Crow Reservation

There are no CBM developments anticipated on Tribal Lands under this alternative, and therefore no impacts are expected. Furthermore, there would be no impacts on the reservation from the use of solid and hazardous materials on off-reservation CBM operations.

Northern Cheyenne Reservation

There would be no impacts on the Northern Cheyenne Reservation from solid or hazardous material use on off-reservation CBM developments.

Conclusion

The cumulative impacts of this alternative would include the solid and hazardous waste generated from conventional oil and gas, surface mining activities, and CBM development. These other activities would result in increased production of both solid and hazardous waste that occur as part of general operation activities. Mitigation would include the disposal of all wastes in accordance with applicable federal, state and local regulations.

Alternative B—Emphasize Soil, Water, Air, Vegetation, Wildlife, and Cultural Resources

The impacts from this alternative would be similar to the impacts under Alternative A. However, CBM

development would result in larger quantities of solid and hazardous waste production.

Crow Reservation

There are no Tribal sponsored CBM developments anticipated on the reservation under this alternative; however, fee lands on the reservation could have private CBM developments. These small developments are expected to generate solid and hazardous wastes in the same proportions as their off-reservation counterparts. These wastes will need to be disposed of in accordance with applicable Tribal and EPA regulations.

There would be no impacts on the reservation from the use of solid and hazardous materials on off-reservation CBM operations.

Northern Cheyenne Reservation

There would be no impacts on the Northern Cheyenne Reservation from solid or hazardous material use on off-reservation CBM developments.

Conclusion

The cumulative impacts from this alternative would be similar to Alternative A. However, the increased scale of CBM development, including the potential development of CBM on the Crow and Northern Cheyenne Reservations and USFS lands, would increase the volume of solid and hazardous waste generated. The increased volume of solid and hazardous wastes would result in local landfills reaching capacity sooner, which would generate the need for the construction of new landfills that would further disturb lands. The additional trucks used for hauling waste would increase traffic and air emissions.

Wastes generated on the Reservations from Tribal development would need to be disposed of following EPA regulations and Tribal laws, if any. This may necessitate the construction of a non-hazardous landfill for the acceptance of solid wastes from the RFFA estimate of 4,000 wells per reservation.

Alternative C—Emphasize CBM Development

The impacts under Alternative C would be the same as for Alternative B.

Alternative D—Encourage Exploration and Development While Maintaining Existing Land Uses

The impacts under Alternative D would be the same as for Alternative B.

Alternative E—Preferred Alternative

The impacts under Alternative E would be the same as for Alternative B.

Vegetation

Vegetation *Emphasis area acreage by land classifications:* *- Grasslands, 3.55 million* *- Shrublands, 1.8 million* *- Forests, 1.36 million* *- Riparian Areas,378,000* *- Barren Lands, 372,000* *87,400 acres currently contain non-native plants and noxious weeds*
Alternative A **No Action (Existing CBM Management)**
• 1,144 acres of native habitat would be impacted under this Alternative, more than half (580 acres) in grasslands. • On non-federal land, Ute ladies'-tresses could be slightly impacted by disturbances
Alternative B **CBM Development with Emphasis on Soil, Water, Air, Vegetation, Wildlife and Cultural Resources**
• 55,400 acres of native habitat could be impacted under this Alternative, more than half (21,450 acres) in grasslands. • On non-federal land, Ute ladies'-tresses could be impacted by disturbances
Alternative C **Emphasize CBM Development**
• 70,000 acres of native habitat could be impacted under this Alternative, more than half (27,300 acres) in grasslands. • If SAR values exceed 10 in water, riparian vegetation would be impacted, affecting as many as 3,535 acres of riparian habitat. • On non-federal land, Ute ladies'-tresses could be impacted by disturbance, SAR values, and water level changes, particularly inundation.
Alternative D **Encourage CBM Exploration and Development While Maintaining Existing Land Uses**
• 55,400 acres of native habitat could be impacted under this Alternative, more than half (21,450 acres) in grasslands. • Hydrology changes may affect as much as 2,776 acres of riparian habitat due to increased stream flow. • On non-federal land, Ute ladies'-tresses could be impacted by disturbance and water level changes, particularly inundation.
Alternative E **Preferred CBM Development Alternative**
• Impacts would be similar to those for Alternative D, however no riparian habitat would be affected.

Assumptions

The Miles City BLM *Seeding* Policy, dated October 27, 1999(c), lists guidelines for seeding practices by typical Montana soil types; it is assumed this policy will be implemented where appropriate. Recommended species are identified for quick coverage of disturbed soils, to discourage invasion of noxious weeds, and to attenuate soil erosion. Reclamation work will be considered complete when the disturbed area is stabilized, soil erosion is controlled, and at least 60 percent of the disturbed surface is covered with the prescribed vegetation.

Under all alternatives, most riparian areas and certain wildlife habitats (see the Wildlife section) are protected from direct impact under current stipulations on BLM land that restrict surface occupancy but not road crossings (BLM 1994).

Surveys to determine the presence of federally listed species would occur on BLM-managed land or mineral estate. The APD requires that BLM determine if the proposed development plan would affect any species listed as threatened or endangered.

Formal consultation with the FWS would occur for site-specific federal CBM projects developed under this EIS if a federally listed threatened and endangered (T&E) species or candidate or proposed species may be affected. Section 7(a) of the Endangered Species Act (ESA) requires that federal actions "are not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or undesirable modification of its habitat." BLM policy for proposed and candidate species is to avoid actions that would jeopardize a species and require formal listing under the ESA.

Special management attention is given by state and federal agencies to state, BLM, and USFS Species of Concern. Agencies approve actions to avoid areas that would jeopardize a species and thereby require federal protection in the future.

The MBOGC environmental review includes an assessment of potential impacts to vegetation during construction and drilling operations. MBOGC policies require the operators to minimize the size of drilling pads and require complete restoration of the area once operations are complete (Administrative Rules of Montana [ARM] 36.22). Mitigation plans are included with the environmental review to notify operators of requirements prior to construction.

For federal actions, FWS is required to provide consultation to federal agencies. They do not have this same requirement for state agencies. Even if a state agency requests a consultation, the FWS does not have the authority to provide it. If a state or private CBM project triggers a federally related action, the FWS

would need to be consulted for federally protected species, by the federal agency.

The FWS would be consulted under Section 10 of the ESA if a federally related action is triggered.

On BLM lands, where specific stipulations do not exist or do not currently apply, there is a presumption that impacts on T&E plant species would be avoided through development and observation of specific conservation measures developed through consultation with FWS intended to avoid impacts on T&E species as required under the ESA.

Impacts on T&E plants on non-federal lands are less likely to be avoided through conservation measures because they are not protected.

Species of concern on all lands would likely receive a relatively high degree of protection at a regional scale because federal and state agencies are committed to avoiding measures that would require listing protection under ESA. However, this would likely not protect all individuals or perhaps some populations within the region.

BLM field clearances and other required pre-exploration activities developed through this EIS process, and which are intended to identify site-specific occurrence of T&E species, would be conducted as specified, leading to knowledge of specific resources and implementation of appropriate avoidance actions and conservation measures discussed above.

Federal and state agency monitoring of exploration, development, and production activities are assumed to be adequate to ensure all lease conditions and ESA requirements are followed.

Preventing the spread of noxious weeds is easier, more successful, and less costly and time-consuming than reclamation or mitigation. Stipulations for current exploration authorizations within the Billings and Powder River RMP areas cover weed management and riparian/wetland management (BLM 1995). Under these stipulations, all categories of noxious weeds must be managed.

Stipulations and options for containment of noxious weeds on state lands are listed in the Minerals Appendix, Table MIN-5.

The BLM has co-developed an action plan for weed containment and eradication practices that will be implemented for all alternatives (BLM 1996). Pertinent sections of Appendix 3 from that document are reproduced in Table 4-51. The action plan applies to the State of Montana's list of weed species of concern (see Table VEG-7, Vegetation Appendix). This list includes species that are considered to be highly invasive and disruptive to natural systems. It is assumed that these weed-prevention activities will be required for CBM exploratory and production sites, roadways, pipelines, utility corridors, and other disturbed sites on BLM land except as specifically noted for some of the alternatives.

Wetlands are legally protected by Section 404 of the Clean Water Act. Therefore, all such wetlands must be surveyed and delineated before any drilling can take place. If wetlands will be impacted by proposed drilling or road alignments, they must be avoided or mitigation measures must be developed to compensate for impact. This compensation may include the development of replacement wetlands. In some instances, Nationwide 404 Permits (NWP) may apply to CBM projects. Applicable NWPs include NWP 12 (Utility Line Activities) and NWP 14 (Linear Transportation Crossings). The producers must meet all terms and conditions of the NWP for it to apply.

On private lands, it is assumed that the private landowner will negotiate with the producer before exploration and development and come to an agreement as to what measures the producer will instigate for weed control, site restoration, and as to what criteria constitutes successful site restoration and proper weed control.

Impacts From Management Common to All Alternatives

Construction of facilities and roads would cause the primary effects on vegetation. For a developed well, a site about 40 percent of the original drill site would remain disturbed for the life of the well (20 years). However, unsuccessful exploratory sites would be reclaimed. Reclamation generally includes spreading topsoil and reseeding according to the landowner's request (private land) or the BLM *Seeding Policy* (BLM 1999c). The BLM *Seeding Policy* and site restoration stipulations do not extend beyond the borders of their lands. Therefore, it is essential that private landholders negotiate with the producer prior to exploration and development on private lands and come to an agreement as to what measures the producer must instigate for weed control and site restoration. This includes what criteria will be used to assess adequate site restoration and proper weed

TABLE 4-51
EXAMPLE: PARTIAL BLM DISTRICT-WIDE WEED PREVENTION SCHEDULE

Prevention Activity	When	Who Is Responsible
Clean off-road equipment with powerwash or high-pressure to remove all mud, dirt, and plant parts before moving into relatively weed-free areas.	All Year	Equipment Operators; Fire Crew
Re-establish vegetation on all disturbed soil from construction, reconstruction, and maintenance activities.	Spring/Fall	Project Proponent
Inspect gravel pits and fill sources to identify weed-free sources. Gravel and fill to be used in relatively weed-free areas must come from weed-free sources.	Spring/Summer	Surface Protection Specialist; Equipment Operator
Retain bonds (for mineral activity) for weed control until the site is returned to desired vegetative conditions.	All Year	Mineral Specialist
Include weed-risk considerations for environmental analysis for habitat improvement projects.	All Year	Wildlife Biologist
Provide weed identification training for field-going employees and managers.	Winter/Summer	Weed Coordinator
Distribute public information/brochures.	Spring/Summer	Public Affairs Officer
Include weed risk factors and weed prevention considerations in Resource Advisor (Environmental Specialist) duties on all Incident Overhead Teams and Fire Rehabilitation Teams.	Summer	Resource Advisor

Note: Revised from BLM 1996.

control. Pre-development agreements are the responsibility of the landowner.

Small areas of vegetation would be lost to roads and drill sites for each well. Dust and vehicle emissions could reduce growth of vegetation adjacent to roads and drill sites. If disturbed areas are prepared and seeded properly, reclamation may further reduce the effects of dust. The effects of drilling on vegetation would be of particular concern under the following circumstances:

- When drill sites or roads are proposed within or cross riparian areas, wooded drainages, or wetlands
- Where drill sites or roads would cause sedimentation or channel down-cutting in riparian areas
- When drill sites or roads would be in areas that contain populations of special status plants
- Where operations could spread or encourage the growth of weeds
- In case of reserve pit leakage
- In the event of blowouts or wildfire

Drilling sometimes may occur in or near areas that support riparian vegetation or special status plants. If located in or at the head of drainages, drill sites and access roads can add sediment to streams and wetlands. Channel degradation can also occur. Heavy sediment loads or severe degradation would affect riparian vegetation. Roads and facilities are supposed to avoid sensitive areas "to the extent practicable."

Therefore many, but not all, sensitive areas such as riparian areas and wetlands would be avoided.

Soil disturbance associated with drilling can cause weeds to spread. Of even greater concern is the long-distance transport of certain weed species by drilling equipment and vehicles. Weed spread is reduced if disturbed areas are re-vegetated during the season of disturbance or the next growing season as recommended (Table 4-51). All well drilling operations are covered by the County Noxious Weed Control Act, which holds landowners responsible for weed control. The contribution of oil and gas drilling to weed spread is comparable to other types of construction.

Because of the legal restrictions placed on the harm or take of federally listed species, direct impacts to these listed species would not occur on federal land. Indirect impacts to federally listed species such as habitat destruction will be addressed on a species-by-species basis. Federally listed plant species on non-federal land ownership may be impacted through conventional oil and gas activities because threatened and endangered plants on private lands are not covered by the ESA.

Mitigation

Site clearance surveys would be conducted prior to disturbance. Where necessary, operator plans would be adjusted as appropriate to avoid impacts to federally listed species.

Review of Montana Natural Heritage Program (NHP) data on a case-by-case basis for Trust Land Management Division (TLMD) Montana Oil and Gas lease sale may indicate areas of plant locations on state lands. A vegetation survey stipulation is used on the lease. For site-specific proposals, the TLMD field staff, may consult with DNRC biologist and Montana-NHP botanists as needed. The TLMD stipulation (see Table MIN-5), reads as follows: “Plant species of concern have been identified on or near this tract. A vegetation survey in areas of proposed activity will be required prior to disturbance. Identified rare plant species will be avoided, unless authorized by the TLMD.”

Conclusions

There would be no impact on federal land to federally listed species. There may be impacts to federally listed plants on non-federal land and to other species of concern.

Impacts From Management Specific to Each Alternative

Alternative A—No Action (Existing CBM Management)

Previous authorizations have allowed selected CBM exploration in the Powder River and Billings RMP areas as well as selected well development and exploration on state lands.

Disturbance to vegetation is of concern because wildlife habitat and livestock production capabilities may be diminished or lost over the long-term through direct loss of vegetation (including direct loss of both plant communities and specific plant species). Indirect impacts, such as noxious weed invasion, erosion, reduced plant species diversity following reclamation, or lack of successful reclamation, could also cause vegetation loss. Under the No Action Alternative, only riparian habitat types and certain wildlife habitats (see Wildlife section) are protected under current stipulations (BLM 1995).

Direct impacts on vegetation would occur during land-disturbing activities associated with installation of exploratory or development CBM wells that remove vegetation to construct a facility (e.g., roads, drilling pads, mud pits, etc.). All direct impacts from exploratory wells are for the life of the well, then rehabilitated. Both temporary and permanent impacts would occur with installation of development wells.

DNRC, TLMD uses buffer stipulations and use of the no-surface-occupancy of navigable riverbeds and related acreage stipulation on its oil and gas leases on a case-by-case basis for protection of riparian habitat. Table 4-52 summarizes the acreage that could be potentially impacted in the two RMP areas and the three counties under state-permitting jurisdiction.

Vegetation types to be potentially impacted were determined based on the extent of each vegetation type overlying coal beds. Impacts to specific vegetation types were assigned in proportion to their total acreage within an ownership (see Table 4-52). For example, there are 1,537,000 acres of grassland in the Powder River RMP area or 40 percent of the total area. Assuming that 200 acres would be permanently disturbed in the Powder River RMP area, 80 acres (40 percent) of permanent, direct impacts would be expected to occur in grassland. If natural communities from Table 4-53 are considered, grasslands would be expected to experience the largest permanent loss (580 acres), based on occurrence. Shrubland would be the next most permanently impacted habitat

TABLE 4-52
AMOUNT OF ACREAGE WITH UNDERLYING COAL BEDS IN EACH HABITAT TYPE (BY RMP AREA AND STATE LAND)[1]

Area	Grassland	Shrubland	Forest Land	Barren Land	Riparian[2]	Agricultural or Other Land Not Included as Native Vegetation
Powder River RMP area	1,537,000 (40%)	920,000 (24%)	897,000 (23%)	210,000 (5%)	180,000(5 %)	136,685 (4%)
Billings RMP area	1,022,000 (40%)	735,000 (29%)	372,000 (15%)	87,000 (3%)	105,0002 (4%)	206,287 (8%)
MBOGC-regulated land	990,000 (56%)	152,000 (9%)	89,000 (5%)	75,000 (4%)	93,000 (5%)	359,151 (20%)

[1]Figure in parentheses indicates percentage of total acreage within the RMP area and MBOGC-regulated land.

[2]These acres are exempt from CBM development as a result of stipulations that omit this type from consideration for CBM exploration and development; they may be affected by water pollution and increased salinity.

TABLE 4-53
ACREAGE POTENTIALLY IMPACTED IN EACH HABITAT TYPE FOR ALTERNATIVE A (BY RMP AREA AND STATE-PERMITTED LAND[1])

	Grassland		Shrubland		Forest Land		Barren Land		Riparian		Other Areas	
Area	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary
Powder River RMP	80	0	48	0	46	0	10	0	10	0	8	
Billings RMP	80	0	58	0	30	0	6	0	8	0	16	
MBOGC-regulated land	420	140	68	23	38	13	30	10	38	13	150	50
Total*	**580**	**140**	**174**	**23**	**114**	**13**	**46**	**10**	**56**	**13**	**174**	**50**

*These estimates were arrived at using GIS data. Sweet Grass and Carter counties did not have enough bituminous coal beds to show up on those layers, therefore CBM well data for those two counties are not included in these estimates. The total acres of impact using GIS data are 1,393 acres. Total real impacts for all counties are estimated to be 1,488 acres.

[1] MBOGC regulated

(174 acres), followed by forest land (114 acres), barren land (46 acres), and riparian habitat (56 acres). Of the 56 permanently impacted riparian acres, 20 are on BLM land, and most are protected by stipulation during exploration.

Indirect impacts may be as important as direct impacts for plants and habitats. As noted earlier, indirect impacts would include the effects of erosion, changes in wildlife and livestock distribution, unsuccessful reclamation, riparian community changes, and the spread of noxious weeds.

Erosion from roads and drilling sites can indirectly affect vegetation from high runoff velocities scouring the plants from the site or by sediment burying the plants. The extent of this potential impact would be determined by the effectiveness of erosion-control measures and the level of enforcement of stormwater management plans. Plant community impacts would be in the same proportions as discussed under direct impacts. The basis of this analysis is formed from the assumption that installation of erosion-control procedures and effective enforcement of stormwater management plans would occur. Implementation of erosion-control measures and stormwater management plans would result in no long-term impacts from erosion. Short-term impacts are still likely to occur from thunderstorms during first few years and from 20 years of active roadbeds.

A total of 250 acres may be reclaimed following temporary disturbance at state-permitted wells. Failure to adequately restore these acres to pre-disturbance conditions would result in a loss of native habitat. Typical seeding mixes only include herbaceous species. When shrub and forest sites are impacted, there would be a loss of structure and diversity of vegetation using the current seeding mix. If reseeding is successful, it would potentially reduce noxious weed invasion, erosion, and dust through restoration of plant cover.

CBM exploration activities could result in the recruitment of noxious weeds by disturbing present vegetative cover, compacting soil, exposing mineral soil to seed fall, and aiding the migration of seeds through movement of vehicles and drilling equipment from site to site. Noxious weeds can indirectly impact native vegetation by out-competing native plants for scarce nutrient, light, and water resources, thereby displacing the native species. Sites with the greatest potential for noxious weed invasion, erosion, or difficulty in restoring to pre-disturbance vegetation are generally sites with pre-existing weed problems or drier sites, such as those designated as barren land. Noxious weeds introduced into a forest environment would be very difficult to control because of access restrictions when weeds spread into deep drainages and timbered hills where chemical control would be difficult. Control of noxious weeds is addressed under current BLM stipulations or state law. The increase in the number and potential for spread of noxious weeds with disturbance is an important consideration even at the current level of exploration and development. This concern is related to other indirect impacts, such as lack of successful reclamation and erosion.

Species of concern include federally listed T&E, and candidate species; Montana species of concern; BLM species of concern, USFS species of concern, and Montana Natural Heritage Program (MNHP) species of concern. For the state, this document addresses only those listed as category S1, which are species of extreme rarity or species for which some factor of its biology makes it especially vulnerable to extinction. The Vegetation Appendix, Table VEG-6 describes and lists all special-status species.

As discussed in the *Species of Concern* section of Chapter 3 in this EIS, there is one federally listed threatened plant species. In accordance with the ESA, this species and its habitat must be protected from possible impact by oil and gas and CBM development on federal land, but not on state or private land. Additionally, 69 species are classified as "species of special concern" by the Montana BLM, USFS, and MNHP. By policy, BLM management cannot impact these species in a way that may cause further declines in the species' population status. This section will address federally listed plant species protected under the ESA.

Species of Concern: Federally Protected

Ute Ladies'-Tresses Orchid

This species is only known to occur in the southwestern part of the state. No development is planned for that part of the state, therefore impacts are not expected to known populations of this orchid from CBM exploration or development.

Crow Reservation

CBM development on the Crow Reservation is expected to be very limited. To the extent that it does occur, impacts to plant communities and natural vegetation would be similar to those described for private lands and would occur on a much smaller scale than on BLM or State lands.

Northern Cheyenne Reservation

CBM development on the Northern Cheyenne Reservation is expected to be very limited. A study of methane gas development on Northern Cheyenne lands concluded that it would be uneconomical (Little Coyote 2001; Herco-Hampton 1989). To the extent that it does occur, impacts to plant communities and natural vegetation would be similar to those described for private lands and would occur on a much smaller scale than on BLM or State lands.

State Species Of Concern

Direct and indirect impacts on other species of concern would be expected to some degree.

Conclusions

Up to 1,105 acres of native vegetation (excluding up to 20 riparian acres on BLM land) would be lost through CBM exploration activities and an additional 250 acres would be temporarily disturbed. Unspecified grazing impacts to native vegetation would occur if displaced animals concentrate in certain areas. Shrub, forested, and barren lands would not be adequately restored using the existing recommended seeding mix, which reseeds only grasses. For all habitats, some reclamation efforts may fail. Strict adherence to reclamation policies would result in no impact to vegetation from noxious weed infestations. However, these guidelines and regulations have been in place for many years and weeds continue to spread across central and eastern Montana. Therefore, some further infestations of noxious weeds would be expected. User-created roads would result in additional loss of vegetation and increased potential spread of noxious weeds (USDI and USDA 2001). No impacts on the Ute ladies'-tress would be expected.

Cumulative Impacts

Cumulative impacts may occur from coal mining operations. Coal mining occurs within the same area covered by this EIS. Vegetation will be destroyed within the disturbed area of a coal mine. As the mine area is reclaimed, topsoil is redeposited and reseeded to reestablish vegetation. Reseeding during reclamation activities will generally result in an increase in grasslands with less plant diversity than was present under pre-mining conditions.

About 92 percent of the coal volume located in the Powder River basin occurs within Wyoming (Ellis et al. 1999) and as many as 50,000 CBM wells may be developed in the Wyoming portion of the basin. The direct and indirect effects of Wyoming CBM development would far surpass the effects of CBM development in Montana under Alternative A because of so many wells. Some rivers entering Montana from Wyoming would be expected to have higher flows, resulting in potential erosion of wetland and riparian communities and habitat degradation.

ESA provisions applied to other projects should avoid cumulative impacts to T&E wildlife species when considered in conjunction with CBM exploration and development.

Alternative B—Emphasize Soil, Water, Air, Vegetation, Wildlife, and Cultural Resources

As listed under Alternative A, four habitat types (grassland, shrubland, forest land, and barren land) will be affected in varying amounts depending on the alternative and the amount of habitat with underlying coal beds. Well development is estimated at 18,300 wells in the RFD, but only 16,470 of these will be production wells. If these wells are distributed evenly over habitats by the proportion of habitats with bituminous coal beds, a total of approximately 55,360 acres would be directly impacted by production wells and dry hole drilling. Approximately 48,864 acres would occur on land with native vegetation: 21,446 acres of grassland vegetation, 13,214 acres of shrubland, 11,680 acres of forest land, and 2,523 acres of barren land could be potentially impacted, if wells were distributed in proportion to the amount of acres in each habitat type. Direct impacts to riparian areas are similar to Alternative A.

Table 4-54 estimates the acres of direct impact for each action alternative based on information in Chapter 2. Direct vegetation loss by habitat type is assumed to be proportional to the relative amount of each habitat type shown in Table 4-53.

As discussed in the Wildlife section, water production and roads can alter the distribution of wildlife and livestock. As wildlife or livestock use is concentrated due to those factors, plant communities can be altered through overgrazing. Overgrazing tends to favor establishment and reproduction of annual and invasive plant species. These species tend to displace native plant assemblages. To the extent grazing animals concentrate in smaller areas, plant communities would change to less diverse, introduced plant communities. Most county weed control efforts focus on herbicide spraying, which reduces plant diversity even more.

TABLE 4-54
ACRES OF LAND AND LENGTH OF ROADS AND UTILITY CORRIDORS DIRECTLY IMPACTED BY NEW CBM CONSTRUCTION

	Alternative			
	B	**C**	**D**	**E**
Area disturbed per well[1, 2]	3.25 acres	4.14 acres	3.25 acres	4.14 acres
Length of roads per well[2]	0.237 miles	0.365 miles	0.237 miles	0.365 miles
Length of utility corridor per well[3]	0.734 miles	1.13 miles	0.734 miles	1.13 miles
Number of wells[2]	18,300	18,300	18,300	18,300
Total area directly disturbed[3]	55,360 acres	70,015 acres	55,360 acres	73,860 acres
Length of CBM roads per square mile[2, 4]	2.9 to 8.8 miles	3.9 to 11.9 miles	2.9 to 8.8 miles	3.9 to 11.9 miles
Total length of CBM roads[2]	6,680 miles	9,018 miles	6,680 miles	9,018 miles
Length of pipeline and utility corridors per square mile[3,4]	9.04 to 27.12 miles	12.2 to 36.61 miles	9.04 to 27.12 miles	12.2 to 36.61 miles
Total length of pipeline and utility corridors[3]	20,679 miles	27,917 miles	20,679 miles	27,917 miles

[1]The land area disturbed and the length of roads and corridors would be 27 percent greater for Alternative C than for Alternatives B and D because transportation corridors and the use of existing disturbed lands would not be required for roads and utilities under Alternatives B and D.

[2] Short-Term

[3] Long-Term

[4]Length of roads, pipelines, and utility corridors per square mile covers the range of 8 to 24 wells per square mile of land overlying 1 to 3 coal seams, respectively. At an average of 8 wells per square mile, 2,287 square miles would be impacted by intensive CBM development. At 24 wells per square mile, 762 square miles would be impacted by intensive CBM development. Additional wildlife habitat surrounding well fields would be indirectly impacted by human activities and presence.

Indirect effects include changes in wildlife and livestock distribution patterns as a result of machinery disturbance or removal of habitat.

When disturbance removes vegetative cover from soil, it is open to erosion from wind and water. Erosion from roads and drilling sites can indirectly affect vegetation from high runoff velocities scouring plants from the site or by sediment burying the plants. The extent of this potential impact would be determined by the effectiveness of erosion-control measures and the stormwater management plans. Types of plant community impacts would be in the same proportions as discussed above but on a much greater scale than for Alternative A.

Existing hydrology and riparian vegetation would not be affected by build-up of salts with this alternative because of the use of injection and holding tanks for production water. The potential for spreading noxious weeds is substantially greater than under Alternative A because 20 times as much land would be disturbed.

Species of Concern-Federally Listed Species

Direct impacts to federally protected species are prohibited by law and are the same as under Alternative A.

The potential for direct and indirect impacts on other species of concern would be much greater under this alternative because of the much larger amount of habitat that will be disturbed or lost with the increased level of vegetation disturbance associated with the greater number of well pads, roads, pipelines, and utility lines. More roadways provide greater access and more potential for disturbance, poaching, or harassing of protected species.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative B. If there were no CBM development on Tribal Lands, then there is expected to be minimal, impacts on vegetation for the reservation. If there is CBM development on the reservation, then the acres of disturbed habitat could be inferred to the reservation using the same approach used in this section.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described in general for this Alternative.

Conclusions

The impacts of CBM development under Alternative B would be substantially greater than under Alternative A because 20 times as many wells would be developed and 20 times as much area would be disturbed.

Reclamation after well abandonment on 44,000 acres may revegetate well sites and roads, but not necessarily restore the sites to previous vegetation or habitats, resulting in native habitat loss.

Cumulative Impacts

Cumulative impacts would be the same as described for Alternative A except that Montana CBM development impacts would be greater.

Alternative C—Emphasize CBM Development

A total of approximately 70,015 acres would be directly impacted. Approximately 62,238 of this acreage would be on sites with native vegetation cover. Approximately 27,316 acres of grassland vegetation, 16,831 acres of shrubland, 14,877 acres of forest land, and 3,214 acres of barren land could be potentially impacted, if wells were distributed in proportion to the amount of acres in each habitat type. Direct impacts to riparian areas are similar to Alternative A. In addition, although no wells will be authorized in riparian areas under any alternative, the discharge of untreated water from exploration and production onto the surface could affect riparian vegetation, perhaps as much as 3,535 acres. This is the estimated average total acreage of habitat with riparian vegetation that is underlain by bituminous coal bed (BLM and state).

Indirect impacts would include the impacts noted earlier of noxious weed invasion, erosion, and changes in wildlife and livestock distribution. In addition, indirect impacts would include increased SAR and salinity levels, which could result in riparian community changes and increased erosion potential for wetland and riparian communities.

Alternative C has the greatest potential for erosion because of the increased disturbance area with no restrictions on corridors for pipelines, utilities and roadways and no requirements for directional drilling or multiple completions in a single well. The extent of erosion would be determined by the effectiveness of erosion-control measures and the stormwater management plans. This alternative will potentially increase the area of disturbance over Alternatives B or D by approximately 15,000 acres (Table 4-54). This acreage increase will increase the potential for erosion.

With discharge of the CBM water to surface drainages and streams, erosion could occur, which could damage or destroy instream and streambank riparian vegetation (Regele and Stark 2000). The erosion could result in increased sediment loads that, along with the potential high salinity and sodicity, could degrade the stream and impact riparian vegetation. Impacts of discharging CBM waters would likely be greatest in intermittent and smaller perennial drainages during low-flow periods. Releases during low-flow periods of late summer and fall would have the greatest potential to impact riparian vegetation. This is also the time when this vegetation is naturally stressed because of low water. The potential for impacts on riparian vegetation exists along drainages and streams throughout the CBM development area.

CBM groundwater discharge has an SAR capable of killing vegetation (Regele and Stark 2000). Plant growth is affected in sodic soils due to decreased soil permeability, increased pH (which lowers nutrient availability), and accumulation of certain elements (sodium, boron, and molybdenum) at a level toxic to plants. Because of the typically low flows of the CBM wells (approximately 5 to 10 gallons per minute), it is likely that these SAR impacts would be localized in the vicinity of the discharge, unless flow were collected from a large number of wells.

Species of concern have a higher potential for direct and indirect impacts compared to Alternative B because of more surface disturbance.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative C.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described in general for this Alternative.

Conclusion

Reclamation of vegetation after well abandonment may revegetate well sites and roads, but not necessarily restore the sites to previous vegetation or habitats, resulting in native habitat loss.

Localized increases in salinity and SAR values may be the most important aspect of this alternative. Salinity can have long-term effects on vegetation, including death of riparian vegetation and concentrations of salt in riparian soils. Soil impacts may last long after a given project site has been abandoned. Increased SAR values may prevent nonhydrophytic reclamation vegetation from succeeding. Increased roads result in more land being disturbed, more wildlife and livestock forage will being removed, and more area for noxious weed invasion being present.

All species of concern that are not federally protected may be impacted by habitat changes caused by vegetation removal that are not fully recovered with reclamation after well abandonment, by increased access through increased roads, and/or by changing streambed hydrology and increased SAR and salinity values in water and soil.

Cumulative Impacts

The types of cumulative impacts are the same as discussed under Alternative A. Disturbed habitat quantities would be similar to those described in Alternative B.

Alternative D—Encourage Exploration and Development While Maintaining Existing Land Uses

Impacts

Impacts on habitat types under this alternative would be the same as Alternative B except for the potential for riparian impacts. Although no wells will be authorized in riparian areas on BLM land under any alternative, the discharge of water from exploration and production onto the surface could create riparian areas that will be abandoned and could affect the hydrology of current riparian areas, perhaps as much as 2,776 acres.

Under this alternative, indirect impacts could include the impacts noted earlier of noxious weed invasion, erosion, and changes in wildlife and livestock distribution. In addition, indirect impacts would likely include increased water being added to riparian systems, which could affect riparian vegetation. Reservoirs that are used in this alternative for holding treated water could produce problems when they are abandoned. Riparian vegetation that developed during the operation dies after abandonment and the bed of the drying reservoir tends to become infested with noxious weeds (Lahti 2001).

Erosion potential may increase under this alternative because there are no reclamation requirements for roadbeds. This is offset somewhat by the stipulation that no slopes greater than 30 percent can be used for CBM construction.

Discharge of water from exploration and production onto the surface could affect the hydrology of as much as 2,776 acres of current riparian vegetation. Changes in hydrology could have both advantageous and undesirable effects on Ute ladies'-tresses through erosion and changed surface and ground water levels.

Other species of concern could be impacted as described for Alternative B and by discharge of CBM water.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative D.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described in general for this Alternative.

Conclusions

There is no requirement for road abandonment so long-term impacts caused by removal of vegetation for roadways is not known, but would occur. Stipulations concerning slope of land for potential CBM sites are likely to protect such slopes from failure and mass wasting problems. A secondary effect is that such areas will remain in their existing habitat and plant communities. Reclaimed areas may revegetate adequately, but this will not restore the sites to previous native vegetation or habitats. There is potential for habitat loss because of the lack of requirements for roadbed reclamation or for abandoned reservoirs. Areas that are not reclaimed would

represent a permanent loss of native vegetation and be subject to noxious weed infestations.

All species of concern that are not federally protected may be impacted by habitat changes caused by vegetation removal that are not fully recovered with reclamation after well abandonment, by increased access through user-created roads, or by changing streambed hydrology and increased SAR and salinity values in water and soil.

Cumulative Impacts

Cumulative impacts from Alternative D would be the same type of impacts as described for Alternative A. The quantity of disturbed habitat would be the same as discussed under Alternative C.

Alternative E—Preferred Alternative

Impacts

The same types of impacts to vegetation and species of concern described for Alternative C would occur under Alternative E because no additional specific mitigation measures will be required and because transportation corridors will not be required. There will be additional impacts in addition to those for Alternative C for the 3,700 wells that will have water basin impoundment structures. This will increase area of total impacts to approximately 73,860 acres. Of this, approximately 66,457 acres of native vegetation will be impacted, 29,168 acres of grassland, 17,972 acres of shrubland, 15,885 acres of forest land, and 3,432 acres of barren land. This Alternative would require a Water Management Plan for every well exploration APD on a site-specific basis for management of production water. There would be no discharge of produced water, either treated or untreated, into the watershed under this alternative unless the operator can demonstrate in the Water Management Plan how discharge could occur without damaging the watershed in accordance with water quality laws. Water quality laws will not protect riparian vegetation from inundation and other changes in the water level as a result of production.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative E.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described in general for this Alternative.

Specific mitigation measures proposed by the Northern Cheyenne Tribe that will be implemented by the BLM are described in the Northern Cheyenne Tribe Mitigation Appendix.

Conclusions

Residual impacts would be the same as described for Alternative C. All species of concern that are not federally protected may be impacted by habitat changes caused by vegetation removal that are not fully recovered after well abandonment and by increased access through increased road densities, which may cause greater disturbance and noxious weed infestations.

Cumulative Impacts

The cumulative impacts from Alternative E would be the same types of impacts as described for Alternative A. The quantity of disturbed habitat would be the same as discussed under Alternative C.

Visual Resource Management

Visual Resource Management *Visual resources include Montana features such as landform, water, vegetation, color, adjacent scenery, uniqueness, structures and man-made features of aesthetic value*
Alternative A **No Action (Existing CBM Management)**
• Federal and State: – Dust emissions would reduce visibility to a small degree near active field operations – Well pads, roads, and compressors would disrupt the visual landscape. Semi-permanent structures are designed to blend into the surrounding environment – Drill rigs, two-track trails, heavy road-making equipment, and generators would disrupt the visual landscape short-term
Alternative B **CBM Development with Emphasis on Soil, Water, Air, Vegetation, Wildlife and Cultural Resources**
• There would be impacts to BLM VRM Class III and IV areas only. • Type of impacts common to Alternative A would occur under Alternative B, at a scale commensurate with development. • View shed impacts from road network could last for 20 years until reclamation occurs.
Alternative C **Emphasize CBM Development**
• Impacts common to Alternative B would occur with Alternative C, in addition to the following: – Above ground powerlines would greatly impact skyline and viewshed. – Visual impacts from roads and utility lines is greatest with this alternative.
Alternative D **Encourage CBM Exploration and Development While Maintaining Existing Land Uses**
• Impacts common to Alternative B would occur with Alternative D, in addition to the following: – Production related roads that are not reclaimed and made part of the permanent road network would result in permanent visual impact.
Alternative E **Preferred CBM Development Alternative**
• Impacts would be reduced by the mitigation measures in the Project Plan for visual resources.

Assumptions

Based on the Visual Resource Management (VRM) class, BLM stipulations and conditions of approval would require special design, including location, painting, and camouflage, to blend with the natural surroundings and meet visual quality objectives for the area. A standard component typically includes painting facilities to camouflage them, and a standard color may be specified.

Impacts From Management Common to All Alternatives

Visual resources would be impacted to varying degrees by oil and gas exploration and production activities. Exploration would involve minor visual impacts from clearing operations for access to exploratory sites. The majority of this impact would be expected to result from access road construction, site construction, drill rig operations, and on-site generator use. Short-term visual impacts would occur where construction and drilling equipment is visually evident to observers. Long-term impacts would occur from construction of roads and pads, installation of facilities and equipment, vegetation removal, and change in vegetation communities. These would produce changes in landscape line, form, color, and texture.

Impacts would occur locally on a case-by-case basis as the native vegetation is disturbed and small structures are erected. Landscape line, form, color, and texture would all be expected to change. The view to travelers throughout much of the Powder River area is a high plain with low-lying scrub-shrub vegetation and periodic rock outcrops. In the Castle Rock Project, there is rough terrain, high hills and buttes, and timber present. Much of the area is very scenic and quite a contrast to the landscape of open prairie that might be found in other areas of the Powder River Basin. Visual impacts may include building roads in rough terrain or cutting timber. Introducing man-made structures into this landscape, although small and painted for camouflage, changes the overall nature of the visual resource.

Four thousand acres of surface mining expansion under permit consideration may be approved this year. This mining activity may affect some visual resources in those areas for the next 20 to 30 years.

Impacts From Management Specific to Each Alternative

Alternative A—No Action (Existing CBM Management)

CBM production well activities would have visual impacts. CBM wells, typically covered in a box, or "housing" for protection from weather, are isolated structures approximately 4 feet high by 4 feet wide by 4 feet long. The wells are scattered across a wide area,

and are connected to field compressors. The compressors are larger, and create more of a visual impact-although in a much smaller area because these structures are more widely distributed. Compressors range in size from field compressors at 8x12x8 (width, length, height; in feet) to sales compressors at 12x18x10. Visual impacts also would arise from construction activities related to developing access to the sites. Exploration well activities may have short-term visual impacts if the exploration wells are not converted to production wells. These short-term impacts (approximately 2 months) would be from the visual effects of the drill rig, portable generator, and access road.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative A. If there were no CBM development on Tribal Lands, then there is expected to be minimal, if any, impacts on visual resources for the reservation.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Conclusions

Exploration wells would cause short term impacts and impacted areas will be repaired on an as needed basis. Minimal permanent visual impacts (approximately 500 acres) are anticipated within the CX Ranch due to well houses, compressor stations, power lines and associated roads

Alternative B—Emphasize Soil, Water, Air, Vegetation, Wildlife, and Cultural Resources

Visual impacts would occur from the development of CBM wells in this alternative for lands in VRM Classes III and IV. VRM Class I and II lands would not be developed and the No Surface Occupancy stipulation applies. The Controlled Surface Use stipulation would be applied to Class III and IV lands. On lands without VRM objectives, a Visual Resource Inventory and Visual Contrast Rating would be accomplished, on a case-by-case basis, to determine the VRM class, visual qualities, site specific impacts and mitigation. On lands with VRM objectives, a Visual Contrast Rating would be completed, on a case-by-case basis, to determine site specific visual impacts and mitigation. Impacts from utilities would be minimal as power lines are buried and other utilities are concentrated within roadway corridors.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative A

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Conclusions

Residual visual impacts would include the impact of the expanded road network when viewed from a distance or from higher elevations. Cumulative impacts would include the visual impact of additional roads when combined with existing roads and new roads being constructed for other uses.

Alternative C—Emphasize CBM Development

For Alternative C, visual impacts would occur from the development of CBM wells for lands in VRM Classes II, III, and IV. VRM Class I lands would not be developed and the No Surface Occupancy stipulation would apply. The Controlled Surface Use stipulation would be applied to Class II, III, and IV lands. On lands without VRM objectives, a Visual Resource Inventory and Visual Contrast Rating would be accomplished, on a case-by-case basis, to determine the VRM class, visual qualities, site specific impacts and mitigation. On lands with VRM objectives, a Visual Contrast Rating would be completed, on a case-by-case basis, to determine site specific visual impacts and mitigation.

Power lines would be aboveground in this alternative and roads would be allowed to be placed according to operator plans. This would result in power lines where none now exist, as well as a wider expanse of roads.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative C.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Conclusions

Residual visual impacts would include the impact of the expanded road network when viewed from a distance or from higher elevations. There also would be a network of power lines visible from many places.

Cumulative impacts would be the same as described for Alternative B.

Alternative D—Encourage Exploration and Development While Maintaining Existing Land Uses

Visual impacts would be the same as described for Alternative B.

Conclusions

Residual and cumulative impacts are the same as described for Alternative B.

Alternative E—Preferred Alternative

Visual impacts would occur from the development of CBM wells for lands in VRM Classes II, III, and IV. VRM Class I lands would not be developed and the No Surface Occupancy stipulation would apply. The Controlled Surface Use stipulation would be applied to Class II, III, and IV lands providing options for lessening the visual impact through design and landscape features. On lands without VRM objectives, a Visual Resource Inventory and Visual Contrast Rating would be accomplished, on a case-by-case basis, to determine the VRM class, visual qualities, site specific impacts and mitigation. On lands with VRM objectives, a Visual Contrast Rating would be completed, on a case-by-case basis, to determine site specific visual impacts and mitigation. Visual contrast Ratings would be completed at the APD or POD stage to identify site specific impacts and determine mitigation.

This alternative does allow for installation of pipelines, power lines and roads where there are none now. But, it also requires that the operator minimize or mitigate impacts from these activities in the Project Plan and state how the surface owner was consulted for input on the location of roads, pipeline and utility line routes. It also allows, at the surface owners discretion, the closing and rehabilitation of roads or the option of leaving them open, after well abandonment.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative E.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described for the Crow Reservation under this alternative.

Conclusions

Use of the mitigation plan as part of the Project Plan would lessen many of the visual impacts but would not eliminate them. New roads and powerlines would be a residual visual impact from this alternative.

There would be cumulative visual impacts from the combination of new and existing roads and utilities.

Wilderness Study Areas

Wilderness Study Areas *There are 10 WSAs within the CBM emphasis area*
Alternative A **No Action (Existing CBM Management)**
• BLM WSAs are closed to oil and gas leasing so there would be no direct impact to WSAs. Because there would be no production activities in BLM planning areas under this alternative, there would be no impacts.
Alternative B **CBM Development with Emphasis on Soil, Water, Air, Vegetation, Wildlife and Cultural Resources**
• No direct impact to WSAs from CBM development.
Alternative C **Emphasize CBM Development**
• No direct impact to WSAs from CBM development.
Alternative D **Encourage CBM Exploration and Development While Maintaining Existing Land Uses**
• No direct impact to WSAs from CBM development.
Alternative E **Preferred CBM Development Alternative**
• No direct impact to WSAs from CBM development.

Assumptions

Wilderness Study Area (WSA) policy prohibits leasing of WSA lands for resource extraction subject to rights associated with valid claims and leases existing at the time of designation.

Impacts From Management Common to All Alternatives

BLM leasing restrictions are designed to protect WSAs from considerable impact. The WSA policy prohibits leasing of these lands for resource extraction. It is expected that WSAs will not be impacted through conventional oil and gas development under current management. Remote areas may be accessed as CBM development proceeds, but this does not mean that WSAs will be impacted. Specific potential impacts to WSAs cannot be quantified until specific development proposals are received.

Impacts From Management Specific to Each Alternative

Alternative A—No Action (Existing CBM Management)

State and fee lands would be impacted by CBM production activity. There would be no production activities in BLM planning areas under this alternative and therefore no impacts from CBM activities.

Conclusion

Impacts from this alternative would be similar to management common to all alternatives. Since stipulations for WSAs prevent leasing of these lands for resource extraction, there are expected to be no major impacts to WSAs.

There are no cumulative impacts from CBM development.

Alternative B—Emphasize Soil, Water, Air, Vegetation, Wildlife, and Cultural Resources

Alternative B would allow development while emphasizing the protection of natural and cultural resources. Under this alternative development would result in increased access to remote areas. The impacts from this alternative would be similar to those described under *Impacts From Management Common to All Alternatives*.

Conclusion

Impacts from this alternative would be similar to those described under Alternative A.

Alternative C—Emphasize CBM Development

Alternative C would emphasize CBM exploration and development with minimal restrictions. The impacts from this alternative would be similar to management common to all alternatives.

Conclusion

Impacts from this alternative would be similar to those described under Alternative A.

Alternative D—Encourage Exploration and Development While Maintaining Existing Land Uses

Alternative D would encourage CBM development while maintaining existing land uses and protecting down stream water consumers. The impacts from this alternative would be similar to management common to all alternatives.

Conclusion

Impacts from this alternative would be similar to those described under Alternative A.

Alternative E—Preferred Alternative

Alternative E, the Preferred Alternative, would allow CBM development subject to existing planning restrictions and balances CBM development and the protection of the natural environment. The impacts from this alternative would be similar to those described under *Impacts From Management Common to All Alternatives*.

Mitigation

The mitigation measures would be the same as those discussed in the management common to all alternatives.

Conclusion

There are no cumulative impacts from CBM development.

Ute ladies-tresses orchid, *Spiranthes diluvialis*

Wildlife

Wildlife

Mammal Species: 10 bats. 8 shrews, 34 small mammals and lagomorphs, 17 predators, 4 big game,
Bird Species: 32 waterfowl, 33 shore & wading birds, 18 diurnal & 11 nocturnal raptors, 8 gallinaceous, 8 wood peckers, 137 songbirds
Reptiles and Amphibian species: 1 salamander, 4 frogs, 4 toads, 3 turtles, 2 lizards, 9 snakes
Species of Concern consist of 16 mammals, 6 reptiles and amphibians, and 22 birds, including: Sage Grouse, Mountain Plover, Bald Eagle, Interior Least Tern, Peregrine Falcon, Gray Wolf, Black-tailed Prairie Dog, Canada Lynx, Black-footed Ferret, Grizzly Bear

Alternative A
No Action (Existing CBM Management)

- Direct impacts include habitat loss, death from vehicle collisions, and effects associated with greater human access into previously untraveled areas.
- Indirect impacts on wildlife include disturbance and displacement, stress, power lines, noxious weed invasion, user-created roads, habitat fragmentation, water quality degradation from road runoff, and increased livestock grazing.
- Indirect impacts on wildlife would occur on 33,840 to 84,000 acres.
- Potential indirect impacts to T&E species, such as human disturbance, increased poaching or collisions with vehicles, would be low because of the limited number of CBM wells permitted.
- Species of concern that are not federally protected may be impacted by habitat loss, disturbance, and habitat changes.

Alternative B
CBM Development with Emphasis on Soil, Water, Air, Vegetation, Wildlife and Cultural Resources

- Same as Alternative A but on a much larger scale. Twenty-five times as many wells, roads, and utility corridors as under Alternative A. 6,680 miles of roads (2.9 to 8.8 miles per square mile). 20,697 miles of utility corridors (9 to 27.1 miles per square mile). Indirect impacts to wildlife on 884,000 to 4.7 million acres from:
- Loss of high value habitats such as prairie dog towns, sage grouse leks, and big game winter range.
- Loss of intermittent wildlife habitat associated with streams because of groundwater withdrawal.
- Potential indirect impacts to T&E species, such as human disturbance, increased poaching or collisions with vehicles could occur, but impact would be less than Alternatives C or D with the restricting of utilities and roadways to the same corridor.
- All species of concern that are not federally protected may be impacted by habitat loss, disturbance, and habitat changes.

Alternative C
Emphasize CBM Development

- Similar impacts as Alternative B. Indirect impacts to wildlife would occur on 884,000 to 4.7 million acres from:
  - Discharge of untreated CBM water into drainages would impact riparian and wetland habitat and associated species because of poor water quality and erosion.
  - Increased livestock grazing within 2 miles of CBM discharges that occur in areas without summer water
  - Potential indirect impacts to T&E species, such as human disturbance, increased poaching or collisions with vehicles, are greater under this alternative than any other because of the increased number of CBM well permits.
  - Potential indirect impacts to T&E species from changes in riparian habitat. Bald Eagles and Interior Least Terns may also be affected if SAR changes affect forage fish.

Alternative D
Encourage CBM Exploration and Development While Maintaining Existing Land Uses

- Impacts would be similar to Alternative B:
  - Discharged treated CBM water would erode riparian and wetland habitat
  - Potential indirect impacts to T&E species, such as human disturbance, increased poaching or collisions with vehicles would occur at a level less than Alternative C.
  - Potential indirect impacts to T&E species from hydrology changes caused by increased water levels may impact nesting Interior Least Terns. If hydrology changes from surface water runoff, cause riparian vegetation changes, other T&E species may be impacted as well, such as nesting Bald Eagles.
  - Species of concern that are not federally protected may be impacted by habitat loss, disturbance, and habitat changes.

Alternative E
Preferred CBM Development Alternative

- Direct and indirect impacts would occur similar to Alternative B.
- Indirect impacts to wildlife would occur on 884,000 to 4.7 million acres depending on development spacing.
- Loss of intermittent wildlife habitat associated with streams because of groundwater withdrawal.
  - This alternative would not directly impact any T&E listed wildlife species. The mitigation measures mandated in the Biological Opinion would be applied to reduce impacts to T&E species.
  - Potential indirect impacts to T&E species, such as human disturbance, increased poaching or collisions with vehicles could occur.
  - Species of concern not federally protected may be impacted by habitat loss, disturbance, and habitat changes. These impacts may be less than under Alternatives B, C, & D through the implementation of the Wildlife Monitoring and Protection Plan.
- More water would be available for wildlife and livestock as a result of CBM production.

Assumptions

CBM exploration, production, and abandonment on BLM-administered minerals is subject to the stipulations summarized in Table 4-55. These stipulations are recommended for, but do not necessarily apply to, CBM-related activities on non-BLM lands. Therefore, the stipulations would avoid some of the potential impacts on BLM lands, but may or may not avoid impacts on non-BLM lands. The success of these stipulations in avoiding impacts would require collection of site-specific information regarding the resources to be protected in relation to exploration, production, and abandonment plans, followed by strict adherence to the terms of the stipulations. For the purposes of this analysis it is assumed that the stipulations offer some protection to wildlife species on BLM-administered lands. It is further assumed that these stipulations which are very species specific, offer some degree of protection to many other species that use the same habitat during the same time period.

The assumption is made that existing stipulations would provide some protection to sage grouse habitat including lek areas, nesting habitat and winter range. It is recognized that these actions would not completely protect this species. Mitigation measures within the Wildlife Monitoring and Protection Plan (WMPP) will provide additional protective measures. Lease stipulations and terms and conditions would provide protection to raptors and the mountain plover. Protective measures contained in the WMPP (if fully implemented) would help reduce, but cannot avoid all, impacts to all species of wildlife including sagebrush-obligate birds.

The DNRC TLMD may apply the following stipulations on a case-by-case basis to school trust lands leased for oil and gas exploration, development, and production. The noxious weed stipulation is placed on all oil and gas leases issued by TLMD. Some of the stipulations indirectly relate to wildlife, while others are more specific. The dates on the timing restriction stipulation vary depending on the wildlife species to which it applies.

- **Notification:** Lessee shall notify and obtain approval from the DNRC's TLMD prior to constructing well pads, roads, power lines, and related facilities that may require surface disturbance on the tract. Lessee shall comply with any mitigation measures stipulated in TLMD's approval.
- **Weeds:** The lessee shall be responsible for controlling any noxious weeds introduced by Lessee's activity and shall prevent or eradicate the spread of those noxious weeds onto land adjoining the lease premises.
- **Sensitive Areas:** This lease includes areas that may be environmentally sensitive. Therefore, if the lessee intends to conduct any activities on the lease premises, the lessee shall submit to TLMD one copy of an Operating Plan or Amendment to an existing Operating Plan, describing in detail the proposed activities. No activities shall occur on the tract until the Operating Plan or Amendments have been approved in writing by the Director of the Department. TLMD shall review the Operating Plan or Amendment and notify the lessee if the Plan or Amendment is approved or disapproved.

  After an opportunity for an informal hearing with the lessee, surface activity may be denied or restricted on all or portions of any tract if the Director determines in writing that the proposed surface activity would be detrimental to trust resources and therefore not in the best interests of the trust.
- Wildlife Restrictions:
  - To protect certain wildlife during periods important to their survival, surface occupancy or other activity shall be restricted from March 15 through July 15 of each year unless otherwise authorized in writing by the TLMD.
  - Potential wildlife conflicts have been identified for this tract. The TLMD would contact either the Montana Department of Fish, Wildlife, and Parks office or the FWS office in the area for advice on alleviating any possible conflicts caused by lessee's proposed activities. Additional mitigation measures may be required.
  - Wildlife species of concern have been identified on or near this tract. A survey in areas of proposed activity may be required prior to disturbance. Identified species would be avoided, unless otherwise authorized by the TLMD. Additional mitigation measures may also be required.
- Miscellaneous Restrictions:
  - Plant species of concern have been identified on or near this tract. A vegetation survey in areas of proposed activity would be required prior to disturbance. Identified rare plant species would be avoided, unless otherwise authorized by the TLMD.

TABLE 4-55
EXISTING WILDLIFE-RELATED LEASE STIPULATIONS COVERING CBM EXPLORATION AND DEVELOPMENT ON BLM LANDS

Resource	No Surface Use	No Surface Occupancy	No Surface Use or Occupancy
Riparian areas		X	
100-year floodplains of major rivers, streams, and water bodies		X	
Water bodies and streams		X	
Crucial big game and sage grouse winter range*	December 1 - March 31		
Elk calving areas*	April 1 - June 15		
Powder River Breaks bighorn sheep range		Within designated bighorn sheep range	
Grouse leks			Within ¼ mile of lek
Grouse nesting zones*	Within 2 miles of leks from March 1 - June 15		
Raptor nests*	Within ½ mile from March 1 to August 1, within ½ mile of raptor nest sites which have been active within the past 2 years.		Within ¼ mile of nest
Bald eagle nests and nesting habitat	Within ½ mile from March to August 1, within ½ mile of raptor nest sites which have been active within the past 2 years.		Within ½ mile of nests active in the last 7 years and within riparian area nesting habitat
Peregrine falcon			Within 1 mile of nests
Ferruginous hawk			Within ½ mile of nests active within 2 years
Piping plover			Within ¼ mile of wetlands identified as piping plover habitat
Interior least tern			Within ¼ mile of wetlands identified as Interior Least Tern habitat
Prairie dog colonies > 80 acres	Controlled surface use		

Note: These stipulations are attached to leases and can affect exploration and construction

*Stipulation does not apply to operation and maintenance of production facilities.

Please refer to Table MIN-5, Minerals Appendix, for a listing of resource mitigation.

  - A critical weed problem exists on this tract. Additional mitigation measures would be required to prevent further spread of noxious weeds. The department may require such measures as power washing of vehicles, car pooling, timing restrictions for seismic, etc. to facilitate this prevention.
  - This tract contains biological weed-control sites, which must be avoided unless otherwise authorized by TLMD.

- Other:
  - Any activity within 1/8 mile of the river or lake/reservoir on or adjacent to this tract must be approved in writing by the TLMD prior to commencement. No surface occupancy would be allowed within the bed of the river, abandoned channels, the bed of the lake/reservoir, or on islands and accretions associated with the river or lake/reservoir.
  - No activity shall be allowed within 100 feet of any perennial or seasonal stream, pond, lake, prairie pothole, wetland, spring, reservoir, well, aqueduct, irrigation ditch, canal, or related facilities without prior approval of the TLMD.
  - Wooded areas on this tract would be avoided unless otherwise authorized by the TLMD.

In addition to these stipulations, motorized vehicle use for recreationists on state trust lands is restricted by current policy to federal, state, and dedicated county roads or other roads regularly maintained by the county, or to other roads that have been designated open by DNRC. Off road use is prohibited. Increased posting efforts, i.e., Walk-In Only signs, may be implemented by the TLMD to reduce unauthorized use of two-track trails and roads by recreationists to alleviate increased pressure on wildlife. Exploration for and development of CBM wells would cause a wide range of both direct and indirect impacts on wildlife. The extent and duration of effects on wildlife would depend on the animal species, the type and quantity of vegetation removed, the nature and period of disturbance, and the success of stipulations in reducing or avoiding some impacts. The impacts described below assume that the site-specific natural resource information and the stipulations discussed above are successfully used to avoid certain impacts on BLM and state lands.

As previously described, the No Action Alternative includes exploration for and development of a relatively small number of CBM wells (compared to the other alternatives) and the associated roads, pads, power lines, pipelines, utility corridors, facilities, and human activities and presence. Many of the direct and indirect impacts of CBM development on wildlife described for Alternative A would occur regardless of the number of CBM wells developed, with the extent of impacts roughly proportional to the number of wells. These direct and indirect impacts are discussed below under the No Action Alternative and referenced as appropriate in the discussion of the impacts of Alternatives B, C, D, and E. Additional ecosystem-level impacts associated with the substantially larger number of CBM wells that would be developed under Alternatives B, C, D, and E are discussed under those alternatives.

Impacts From Management Common to All Alternatives

The responses of wildlife to facilities and activities associated with oil and gas development are complex but well documented (Wisdom et al. 2000; USDI and USDA 2001; Trombulak and Frissell 2000). Tolerance of various types of environmental disturbances varies among species and among individuals of the same species. The potential for impact is related to the timing and nature of the disturbance, severity of winter, location in the state, habitats and species present, physiological status of the animal, hunting pressure and other disturbance factors, and predictability of the disturbance. The scale of oil and gas development, number and length of associated roads and other facilities, and implementation of measures to avoid or reduce impacts also influence the probability and severity of impacts on wildlife.

Direct and indirect impacts of road construction and use on wildlife and wildlife habitat have been well documented for oil and gas projects and other natural resource developments. Impacts include a wide range of biological effects, such as habitat loss, displacement because of noise and human disturbance, and stress. The types of impacts expected to result from oil and gas development would be similar to those described in detail under Alternative A for CBM development. The extent of the impacts would vary depending on the level of development.

A detailed discussion of impacts and mitigation measures for wildlife is included in the remainder of this section and in the Wildlife Appendix. This discussion addresses the direct and indirect quantitative and qualitative impacts that would likely result from CBM development in the Powder River and Billings RMP areas. The impacts from conventional oil and gas development would be similar

to those anticipated for CBM but at a scale associated with conventional oil and gas development as identified in the Miles City District's *Oil and Gas Final EIS*, (BLM 1992).

Impacts From Management Specific to Each Alternative

Alternative A—No Action (Existing CBM Management)

CBM exploration and production includes development of roads, pads, power lines, pipelines, utility corridors, and facilities as well as human activities and regular human presence. Much of this activity would occur in the relatively undisturbed native short grass prairie of eastern Montana, resulting in both direct and indirect impacts on wildlife. Those impacts would be localized around CBM exploration and production sites and proportional to the level of activity at a particular location. The following discussion documents the types of impacts that would be expected from CBM-related actions. These impacts would occur on BLM, state, and private lands.

While the types of impacts described below would occur under all of the alternatives, the extent of the impact would be roughly proportional to the extent of CBM development under each alternative. The number of CBM exploratory and development wells under the No Action Alternative is 1/20th the number that would be developed under the other alternatives. Therefore, the extent to which these impacts would occur under the No Action Alternative is relatively minor compared to the other alternatives.

With a few exceptions, the same types of impacts to wildlife would occur under all of the alternatives. Therefore, they are described under Alternative A below. Differences in the type or extent of impacts between alternatives are noted for Alternatives B, C, D, and E.

Direct habitat loss and direct and indirect impacts because of habitat disruption and wildlife disturbance caused by roads, pipelines, and utility corridors would cause the bulk of the impacts on wildlife. Numerous studies have documented the direct and indirect impacts on wildlife from road development, human presence in formerly remote areas, and facilities construction (Trombulak and Frissell 2000, Wisdom et al. 2000). The nature of these impacts and how they relate to exploration, development, and maintenance of CBM wells is discussed in the text that follows. In most instances, the impacts would occur during all CBM phases. Exceptions are noted as appropriate.

Direct impacts would include loss of habitat to accommodate project features. They would persist for the duration of CBM activities and, in the case of loss of habitat value, beyond that time. Some degree of habitat loss and degradation would continue following CBM abandonment because of ecological differences between reclaimed sites and native vegetation.

The amount and types of habitat that would be directly lost from exploration and development are described in the Vegetation section. The species that would be affected by direct habitat loss would depend on the location of CBM exploration and development and the types of habitat affected. Based on the average area expected to be disturbed by exploration and development of each CBM well, about 675 acres would be impacted during exploration, a total of 1,500 acres would be impacted in the short term by well development (including the 675 exploration acres), and 500 acres would be subject to long term impacts during operations under Alternative A. Direct impacts on wildlife would also include mortality as relatively less mobile small mammals, reptiles, and amphibians are killed during road and other site construction. Smaller mammals, reptiles, and amphibians are most likely to be directly killed by vehicles and are vulnerable when crossing roadways (USDI and USDA 2001). Amphibians are especially vulnerable to being killed on all types of roads because their life histories often involve migration between wetland and upland habitats and individuals are often inconspicuous and slow-moving. Inexperienced juveniles of many raptor species experience high rates of mortality from collisions with vehicles (Trombulak and Frissell 2000). Grouse are particularly susceptible to collision mortality during the spring because they often fly to and from leks near the ground. Also, higher CBM-related traffic volumes on existing paved roads would result in higher mortality rates for reptiles that seek out roads for thermal cooling and heating (Vestjens 1973). Direct mortality from vehicle collisions would be expected to increase for all wildlife along both new and existing roads used for CBM exploration and well construction and maintenance (Groot et al. 1996). Collision mortality would be most injurious to small and declining populations with limited distribution. Direct impacts from collision and crushing would continue for the duration of the project along roads until they are successfully closed and reclaimed. Some additional mortality would continue indefinitely because some new CBM roads would not be closed and reclaimed.

Additional direct impacts would occur on private lands because state and federal lease stipulations are recommended but not required. State requirements

would lessen direct impacts on state lands compared to private lands. These impacts include greater potential loss of riparian vegetation and other floodplain habitats valuable for wildlife, abandonment of raptor nests because of direct habitat loss and disturbance, and habitat loss for a wide range of species that occupy prairie dog towns. Note that the percentage of private-lands overlying known coal reserves within the emphasis area accounts for approximately 39 percent.

Table 4-56 indicates the relative level of vulnerability of different representative types of wildlife to direct and indirect impacts. Most indirect impacts on wildlife would occur during all CBM phases on BLM, state, and private lands. The duration of effects would correspond with the duration of each phase and the intensity of activity during that phase. The relative magnitude of impacts would be directly related to the nature and extent of activities associated with each phase of CBM development. Some indirect effects would persist beyond abandonment because continued human use of some CBM and user-created roads that are not closed and reclaimed (USDI and USDA 2001).

Indirect impacts of road development and use as would occur during exploration, development, and production on wildlife and wildlife habitat have been well documented for a variety of natural resource extraction and development projects (Trombulak and Frissell 2000, USDI and USDA 2000, Wisdom et al. 2000). Indirect impacts of CBM exploration and development on certain species of wildlife that are more sensitive to development and human disturbance would occur over much larger areas than the direct impacts.

The *Oil and Gas Development on the Southern UTE EIS* (BLM 2002c) suggested that human presence associated with exploration and development of oil and gas wells disturbed wildlife at distances up to 1/2 mile, and that operation and maintenance activities caused disturbance within 1/4 mile of wells and roads. The disturbance results both from the presence of people and from the noise associated with exploration and development. There are numerous studies documenting wildlife avoidance of roads and facilities and wildlife disturbance at distances of 1,650 feet (Madsen 1985), 6,600 feet (Van der Zande et al. 1980), and as far as 2 miles or more for sage grouse (summarized in Connelly et al. 2000) and raptors (Fyfe and Olendorff 1976).

Elk avoidance of roads has been documented in many studies throughout the West (Lyon 1979 and 1983, Perry and Overly 1976, Rost and Bailey 1979, Ward et al. 1973). Human presence along roads displaces big game species such as elk as well as other species sensitive to human presence from otherwise useable habitat, especially during the day. Elk in Montana prefer spring feeding sites away from visible roads (Grover and Thompson 1986) and both elk and mule deer in Colorado prefer areas greater than 660 feet from roads during the winter (Rost and Bailey 1979). Lyon (1983) studied the effects of roads on elk distribution and habitat use. He reported that within blocks of available elk habitat, road densities of only 2 miles of primitive (undeveloped) road open to vehicle traffic per square mile resulted in elk displacement from over 50 percent of the available habitat in the areas with roads present. The avoidance was due to human disturbance and the resulting lack of security for the elk. This type of disturbance would be greatest in open country such as much of the EIS planning area where line-of-sight distances are relatively long and escape cover is often limited.

Displacement from habitat because of roads, CBM facilities, and human disturbance may result in any of a number of individual and population level impacts on wildlife (Trombulak and Frissell 2000, Wisdom et al. 2000). These include stress, disruption of normal foraging and reproductive habits, abandonment of unique habitat features, and increased energy expenditure. These factors contribute to reduced over winter survival for individuals, poor condition entering the breeding season, reduced reproductive success and recruitment, and eventually population declines (Trombulak and Frissell 2000, Wisdom et al. 2000). For sensitive species, displacement from important habitat features is effectively equal to loss of habitat and the individuals that occupied that habitat. Wildlife cannot generally just move to unoccupied habitat in response to disturbance and survive there because other suitable habitat is already occupied by other individuals of the same species or by similar species using the available resources.

CBM-developed roads and two-track trails would provide public access into previously roadless areas and would result in additional user-created roads and trails branching off from CBM roads (USDI and USDA 2001). Access to most CBM roads on private lands would be restricted by the surface owner. Public access would be restricted on most CBM roads on BLM lands through the use of fences and gates. This is expected to be successful in limiting the majority of public access. However, the open rolling nature of the terrain in the project area combined with the proliferation of four-wheel-drive trucks and all-terrain vehicles would allow the creation of user-created roads (USDI and USDA 2001). This would cause additional road-related direct and indirect impacts over large open areas because of the great sight distances in central and southeastern Montana.

TABLE 4-56
VULNERABILITY OF WILDLIFE TO TYPES OF CBM IMPACTS, ALTERNATIVE A

(The relatively low impact probabilities in this table reflect the fact that the no action alternative includes a small number of CBM wells compared to the other alternatives)

	Species/Groups Affected [1]																			
	Big Game/Large Predators [2]		Sage and Sharp-tailed Grouse [2]		Raptors [2]		Waterfowl/ Shorebirds		Song Birds		Prairie Dog Colonies		Small Mammals		Reptiles and Amphibians		Bats		Small Predators	
Type of Impact	**Exploration**	**Devel/Ops**	**Exploration**	**Devel/Ops**	**Exploration**	**Devel/Ops**	**Exploration**	**Devel/Ops**	**Exploration**	**Devel/Ops**	**Exploration**	**Devel/Ops**	**Exploration**	**Devel/Ops**	**Exploration**	**Devel/Ops**	**Exploration**	**Devel/Ops**	**Exploration**	**Devel/Ops**
Direct Impacts																				
Habitat loss	1	2	1	2	1	2	0	0	1	2	2	3	1	2	1	1	2	2	1	2
Vehicle collision / crushing	1	2	2	3	1	1	0	0	1	1	1	2	3	3	3	3	0	0	0	1
Greater public access (increased poaching, fire, and legal hunting)	1	3	1	2	1	2	1	1	0	0	1	2	0	1	0	1	0	1	2	3
Indirect Impacts																				
Disturbance and displacement from CBM-associated human presence and activities.	3	3	3	3	3	3	2	2	2	2	1	1	2	2	1	1	0	1	1	2
Noise disturbance/displacement/stress	2	2	3	3	1	1	1	1	3	3	0	0	1	1	1	1	1	1	1	2
Above-ground power lines	0	0	0	3	0	3	0	2	0	2	1	2	0	1	0	0	0	0	0	0
Noxious weed habitat degradation	0	2	0	2	0	2	0	0	0	2	0	1	1	2	0	1	0	0	0	1
Presence of new CBM and user-created roads	0	3	0	3	0	2	0	1	0	2	0	2	0	2	0	2	0	0	1	2
Habitat fragmentation	0	1	0	2	0	1	0	0	0	1	0	1	0	1	0	1	0	0	1	2
Sediment runoff from roads and excess CBM water/water quality degradation	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	1	2	0	0
Altered surface hydrology (springs and small stream flows reduced)	0	1	0	2	0	0	0	1	0	1	0	0	0	1	0	2	0	1	0	1
Increased livestock use of range due to CBM water sources	0	2	0	3	0	2	0	2	0	3	0	0	0	2	0	2	0	0	0	1

Notes:
Vulnerability of wildlife to categories of impacts are based on the nature of impact, species involved, and relative number of wells.
0 = little or no vulnerability
1 = low vulnerability
2 = moderate vulnerability
3 = high vulnerability

[1] Relative vulnerability assumes collection of site-specific data needed to follow stipulations during exploration and development on BLM lands, and strict adherence to stipulations.
[2] Vulnerability would be slightly lower for certain habitat components on BLM lands during exploration, than on non-BLM lands.

For example, many raptor species that nest along prominent landscape features such as cliffs in open country are easily disturbed during the nesting season, often resulting in nest abandonment (Fyfe and Olendorf 1976). Some CBM roads would continue to be used by the public, including hunters, throughout the entire production phase because road closures are difficult to implement and enforce in flat to rolling short grass prairie habitat. This continued use would hamper reclamation efforts on some CBM roads while others would remain open to the public by choice. Some portion of CBM roads, as well as user-created roads, would become permanent, with all of the associated direct and indirect impacts on wildlife and habitat.

Human use of all types of roads is a source of stress for many species. Roads also may affect an animal's reproductive success (Gutzwiller 1991). Golden eagles prefer to nest away from human disturbances, including roads, and have reduced nesting success in nests located closer to roads than in nests farther from roads (Fernandez 1993). Chronic physiological stress on wildlife can result in increased sickness, a decrease in individual productivity (Knight and Cole 1991, Anderson and Keith 1980, Yarmoloy et al. 1988), and eventually result in population declines (Anderson and Keith 1980).

The increased access provided by both CBM and user-created trails and roads over the span of all CBM phases and beyond would result in additional legal harvest and illegal poaching of game animals (Cole et al. 1997), target shooting of animals such as prairie dogs and other similar species (Ingles 1965), and chasing and harassing of animals (Posewitz 1994, USDI and USDA 2001). Human-caused fires are likely to increase in areas that were not regularly accessed by the general public before CBM and user-created roads were present.

Overhead power lines constructed for production wells pose problems for a variety of wildlife species. Raptors and other species of birds occasionally collide with power lines, especially during periods of relatively poor visibility. Overhead power lines can benefit some raptors in open country by providing hunting perches. However, the additional perches also result in local population declines in prey species. For example, overhead power lines constructed in the vicinity of sharp-tailed grouse leks and wintering areas can substantially increase predation rates on the grouse. The risk of electrocution on federal and state lands is very small because the BLM and State would require that all power lines and poles be constructed to standards that would avoid raptor electrocution. Raptor and sage grouse collisions with power lines have also been noted throughout the west including eastern Montana.

Another wildlife disturbance factor associated with CBM exploration, development, and operation is noise. The highest noise levels and greatest impacts would be expected during exploration and development, with lower noise levels during production operations. Noise levels would be similar on BLM and other lands. Animals would react to noises, but it is especially troublesome for songbirds. Male neotropical migrant birds that breed in short grass prairie, sagebrush, and riparian communities use songs to establish and defend breeding territories and attract females. Noise interferes with this ability, with the level of interference related to the volume and frequency of the noise (Luckenbach 1975, Luckenbach 1978, Memphis State University 1971, Weinstein 1978). Other noise-related problems for birds around CBM exploration and production wells and compressors include interference with the ability to recognize warning calls and calls by juveniles, both of which can result in higher predation rates. The area of disturbance would vary by species and CBM activity. Producing wells would be relatively quiet once regular production is underway. Compressors would be louder with noise levels limited to 50 decibels at a distance of 1/4 mile.

Stipulations prohibit surface occupancy in riparian areas and on floodplains of major rivers. However, they do not prohibit crossing of streams or construction of roads through riparian areas. Roads constructed through riparian areas and other forest and shrub stands for CBM development and operation create edge effects and alter the physical environment (Trombulak and Frissell 2000). Roads create drier conditions in the vicinity of the road, thereby altering habitat for many species. In grassland and shrubland habitats, trails and roads create edge habitat for predators and reduce patch size of remaining habitat for area-sensitive species (USDI and USDA 2001, Ingelfinger 2001). Swihart and Slade (1984) found that prairie voles (*Microtus ochrogaster*), which occur in the EIS planning area, were reluctant to cross tire tracks running through an open field. Reluctance to cross narrow gravel roads has also been observed in white-footed mice (*Peromyscus leucopus*), which also occur in the EIS planning area, and many other rodent species (Mader 1984, Merriam et al. 1989, Oxley et al. 1974). Consequently, roads can function as barriers to population dispersal and movement for small mammals that occur in the EIS planning area.

Many amphibian's annual life cycles require migration between habitats with different ecological properties. These species' populations depend on dispersal connections and landscape links (Gibbs 1998). Simple

linear structures such as roads of all types can act as physical and psychological barriers for amphibian movement (Mader 1984, Gibbs 1998). Furthermore, motorized off-highway travel may disrupt reptile and amphibian habitat to the point where it becomes unusable (Busack and Bury 1974). Pronghorns and mountain lions have also demonstrated reluctance to crossing roads (Bruns 1977, Van Dyke et al. 1986).

Noxious weeds and exotic plants rapidly colonize disturbed sites, prevent native species from being re-established following ground disturbance, spread into undisturbed areas reducing habitat value on additional lands, and provide very poor quality wildlife habitat or forage. Mitigation measures discussed under vegetation are intended to avoid, reduce, and control new infestations of noxious weeds through a variety of actions. Consistent and successful application of these mitigation measures would reduce potential habitat degradation. However, use of chemicals to control noxious weeds usually also kills non-target beneficial native plants, contributing to habitat loss.

Roads are sources of fine sediment that can enter wetlands and intermittent and perennial drainages, especially following thunderstorms. Effects include increased turbidity (Reid and Dunne 1984), smothering wetland vegetation, and degradation of habitat for amphibians and other aquatic life (Newcombe and Jensen 1996).

There are no apparent differences between indirect impacts on wildlife on BLM and state lands. Impacts on private lands would be much more substantial because stipulations and mitigation measures would not apply.

Species of Concern

Species of concern include federally listed T&E and candidate species; Montana species of concern; BLM species of concern, USFS species of concern, and MNHP species of concern. For the State of Montana species of concern, this document addresses only those listed as category S1, which are species of extreme rarity or species for which some factor of its biology makes it especially vulnerable to extinction. Chapter 3 of the EIS describes and lists all special-status species.

As discussed in the *Species of Concern* section of Chapter 3 in this EIS, there are 9 federally listed threatened, endangered, and proposed species; and 3 federal candidate species. In accordance with the ESA, listed wildlife must be protected from possible impact by oil and gas and CBM development on all lands. ESA protected plants are not protected on private lands. Additionally, there are many species classified as "species of special concern" by the Montana BLM and MNHP. By policy, BLM management cannot impact these species in a way that may cause further declines in the species' population status. These include 68 plant, 16 mammal, 6 herptile, and 22 bird species, and are listed by the state, BLM, and USFS. This section will address federally listed wildlife species protected under the ESA. General recommendations for other species of concern wildlife species can be found within the general Wildlife impact sections. Federally listed species are discussed individually because of the need for species-specific mitigation measures to avoid extensive impacts. Conclusions are summarized after all of the species are discussed.

Federally Listed Species

Bald Eagle

Bald eagles are sensitive to human presence. Disturbance to foraging, resting, roosting, or migrating eagles is possible through surface use in other areas not addressed by stipulations. Based on the assumptions listed in the introduction to the *Wildlife* section, protection of nests and nesting habitat should prevent eagles from abandoning traditional nesting sites in the project area, but periodic or complete abandonment of non-nesting habitat may occur depending on the level of human use and noise. Above-ground transmission facilities could result in the death of some bald eagles because of electrocution. However, the risk of electrocution on federal and state lands is very small because the BLM and State would require that all power lines and poles be constructed to standards that would avoid raptor electrocution (Table MIN-5). Power lines also pose strike hazards for bald eagles, especially near perennial rivers and water bodies that support fish and waterfowl. Removal of large trees in wintering areas, particularly at established roost sites, would also displace bald eagles by removing perch and roost sites.

Mountain Plover

Mountain plover are most susceptible to disturbance during the nesting season, which occurs between mid-April and early July. Construction activity and operations and maintenance could disturb the nesting/courting birds during this period. Noise and the presence of humans and equipment would be the main causes of disturbance. The absence of stipulations to protect mountain plover nesting areas (prairie dog towns smaller than 80 acres) would result in impacts on this species if exploration or development occurs in or near occupied nesting habitat. Prairie dog towns often are located on flat, topographically low areas.

Interior Least Tern

As with mountain plover, this species is susceptible to disturbance during the nesting period.

Gray Wolf

Roads and the presence of humans would increase the threat from shooting, either on purpose or accidental (when mistaken for a coyote). The potential density of roads in occupied wolf areas could force wolves from occupied areas and could increase stress on wolves and result in the loss of some individuals.

Canada Lynx

Canada lynx would be expected mainly in western and south-central Montana, where high-elevation, dense, old-growth forests are most likely to be found. Although possible, exploration and development of CBM are not expected to occur in these habitats. Therefore, there would be no impacts to Canada lynx.

Black-Footed Ferret

Black-footed ferrets are exclusively found associated with their main prey species: prairie dogs. Prairie dogs are found throughout the project area. Any activity affecting prairie dog colonies has the potential to impact the ferret. Prairie dog colonies are frequently located on level to slightly sloping ground. Two BLM leasing stipulations address black-footed ferret concerns. The first states that exploration in prairie dog colonies within potential black-footed ferret reintroduction areas comply with the Draft Guidelines for Oil and Gas Activities in Prairie Dog Ecosystems Managed for Black-footed Ferret Recovery (FWS 1988, BLM 1992). If these guidelines are accepted, they specify that conditions of approval depend on the type and duration of the proposed activity, proximity to occupied ferret habitat, and other site-specific conditions. Exceptions or waivers of this stipulation may be granted if the Montana Black-Footed Ferret Coordination Committee determines that the proposed activity would have no disagreeable impacts on ferret reintroduction or recovery. The status of the Fort Belknap population allows them to be treated as a proposed species, which may require a conference with FWS if impacts are expected in the vicinity of the reservation.

The second stipulation requires that all prairie dog colonies or complexes greater than 80 acres in size be surveyed for black-footed ferret absence or presence prior to ground disturbance. Prairie dog complexes may consist of several smaller colonies located near one another. The results of the survey determines if restrictions or denial of use are appropriate for the site. Permits issued by MBOGC do not have the same stated requirements for protection of prairie dog towns of certain sizes; however, the ESA's protection of listed wildlife does apply to state and private land. Operators are prohibited from causing harm to the ferret. As appropriate, state leases would include a survey stipulation or contact MFWP stipulation for species of concern.

Implementation of stipulations in potential and occupied habitat would avoid impacts to the ferret on BLM land.

Grizzly Bear

Threats to grizzly bears mainly result from human-bear interactions, which occasionally end in the death of the grizzly bear. If exploration moves into sparsely settled areas or previously roadless areas within grizzly bear range, the possibility of bear-human interaction increases.

Federal Candidate Species

One candidate species may potentially be found in the project area: the black-tailed prairie dog. Although not subject to the substantive or procedural provisions of the ESA, FWS encourages no action be taken that could impact candidate species and contribute to the need to list the species. The state also has a policy that the state should take no action that could contribute to these species being listed.

Black-Tailed Prairie Dog

As discussed under black-footed ferret above, BLM has stipulations governing activities that could impact black-tailed prairie dog towns larger than 80 acres if ferrets are found to be present. However, these protections do not apply if the ferret is not present. The MFWP through a working group composed of state, federal, and private individuals is developing a Prairie Dog Conservation Plan to address how to avoid continuing impacts, which are resulting in population declines. There are no special protective measures being implemented by the state or BLM at this time, although an evaluation including associated impacts to other listed species, in order to identify measures to avoid impacts is required. Construction of CBM exploration and production wells on all land ownerships is expected to impact black-tailed prairie dog towns.

BLM, USFS, and Montana Species of Concern

Under all alternatives, the variety of life forms and the large number of species of concern, the lack of specificity of project locations, and the wide variation in habitat used by these species preclude the ability to identify specific impacts to each individual species of concern. Exploration and development of CBM wells would result in a variety of direct and indirect impacts to species of concern. Specific impacts would depend on the species, the amount and type of habitat removed, and the nature and period of disturbance. Leasing stipulations as discussed above and in the *Wildlife* section would offset or offer some protection to federally listed species. However, there are no stipulations for most species of concern.

Alternative A presents a discussion of impacts to all wildlife species, of which species of concern are a subset. That discussion is not repeated here and the reader should refer to the *Wildlife* section for an understanding of impacts to wildlife species of concern. Some of these species are particularly vulnerable because of their scarcity or narrow habitat niche.

Guidelines recently developed by Connelly et al. (2000) to manage sage grouse populations and their habitat indicate that the stipulations stated above that are intended to avoid impacts on sage grouse leks, and nesting areas during exploration are not adequate to do so. Sage grouse are extremely sensitive to human disturbance and habitat alteration and breeding populations have declined dramatically throughout much of their range (Connelly and Braun 1997) including south-central and southeastern Montana (Eustace 2001). MFWP has been monitoring certain sage grouse leks in south-central Montana since the early 1980s. There has been an approximate 50 percent reduction in the number of these active leks since the monitoring began. Eustace attributes this decline to habitat loss and human disturbance and stated that he believes similar declines have occurred in other portions of Montana. Connelly et al. (2000) indicate that energy-related facilities should be located at least 2 miles from sage grouse leks. They further note that sage grouse populations display four types of migratory patterns: 1) distinct winter, breeding, and summer areas; 2) distinct summer areas and integrated winter and breeding areas; 3) distinct winter areas and integrated breeding and summer areas; and 4) non-migratory populations. Furthermore, recent studies in eastern Idaho have found that sage grouse wintering areas may vary considerably from year to year depending on snow accumulation (Kemner and Lowe 2002).

Avoiding impacts on sage grouse requires protecting the integrity of all seasonal ranges. Average distances between leks and nests vary from 0.7 to 3.9 miles (Autenreith 1981, Wakkinen et al. 1992, Fischer 1994, Hanf et al. 1994, Lyon 2000), and movements between seasonal ranges may exceed 45 miles (Dalke et al. 1963, Connelly et al. 1988). Furthermore, sage grouse have high fidelity to all seasonal ranges (Keister and Willis 1986, Fischer et al. 1993). Females return to the same area to nest each year (Fischer et al. 1993) and may nest within 660 feet of their previous year's nest (Gates 1983). However, other studies by Lyon 2000, Fischer et al. 1993, and Berry and Eng 1985 found average distances of 683 meters (2,240 feet), 740 meters (2,427 feet), and 552 meters (1,811 feet), respectively. Therefore, while important, protecting a 1/4-mile (1,320 feet) radius area around leks as specified in the stipulations, may be inadequate to avoid impacts on displaying and nesting birds. Furthermore, this stipulation does not provide sufficient protection of the breeding area or any wintering areas. This stipulation is not adequate to avoid all the impacts on sage grouse from CBM activities. Sage grouse would be impacted by CBM activities that occur within 2 miles of sage grouse leks or within winter range.

Overhead power lines constructed for production wells pose several problems for sage grouse. Sage grouse occasionally collide with power lines, especially during periods of relatively poor visibility. Overhead power lines provide hunting perches for raptors. Predation rates on sage grouse increase dramatically when these lines are located in the vicinity of sage grouse leks and wintering areas, resulting in population declines (Connelly et al. 2000, Milodrgovich 2001).

As discussed in the *Hydrological Resources* section, surface water bodies would not be impacted directly from groundwater withdrawal due to the depth and confined nature of the individual coal seams. In the unlikely event that there is a very localized connection between a spring-fed stream and groundwater withdrawals, effects on wildlife and habitat would include drying of springs, and reduced flow and duration in intermittent and small perennial drainages. Sage grouse could be severely impacted, as broods spend much of July and August in more mesic sites as sagebrush habitats desiccate (Gill 1965, Savage 1969, Connelly and Markham 1983, Fischer et al. 1998). Reduced availability of mesic sites would reduce sage grouse brood survival and unfavorably affect populations (Connelly et al. 2000).

Crow Reservation

Off reservation CBM development would not indirectly impact wildlife on the Crow Reservation.

Northern Cheyenne Reservation

There would not be any indirect impacts to wildlife on the reservation associated with off-reservation CBM development at the CX ranch.

Mitigation

Agency-applied mitigation measures for BLM and state lands related to natural resources are presented in Chapter 2, and Table MIN-5 of the Minerals Appendix. Agency-applied measures would be implemented as needed and enforced during all CBM phases. Agency-applied mitigation measures are intended to compensate after-the-fact for some impacts that are not avoided through standard lease stipulations. Residual impacts are those that remain after implementation of mitigation measures.

BLM would include and enforce agency applied mitigation (described in Chapter 2 and the Minerals Appendix) through application of standard lease stipulations as needed during the site-specific plan approval stage. Measures to further avoid or reduce impacts in addition to those included at the plan approval stage may be recommended. The state would apply additional mitigation measures on a case-by-case basis through the use of field rules.

Species of Concern Mitigation Measures

Bald Eagle

Before construction begins, a wildlife biologist would survey the construction zone within a 0.5-mile width for bald eagles and bald eagle nests and identify any locations that are found. The use of no surface occupancy or no use stipulations within 0.5 miles of known nests or riparian nesting habitat would reduce but not eliminate potential impacts to nesting, foraging, and roosting bald eagles.

Mountain Plover

Surveys would be made of all prairie dog towns within the roadway corridor and pad sites prior to exploration. If prairie dog colonies or several of the other indicators are found, FWS survey protocol for mountain plover would be followed. See the Wildlife Appendix Biological Assessment for Mountain Plover Survey Guidelines. This includes surveying from May 1 through June 15 for presence or absence on potential sites. Exploration and Construction would be avoided in these areas during this time period to assure that potential nesting mountain plovers are not prevented from setting up territories as a result of the presence of equipment and humans.

Interior Least Tern

Potential habitat near exploratory drilling and construction sites would be identified and appropriate surveys would be conducted for this species. Surface occupancy and use is prohibited within 1/4 mile of wetlands used by nesting interior least terns during exploration. This stipulation would minimize impacts to interior least tern. Occupied wetlands and water levels would be protected in all phases of drilling and construction and no discharge into occupied wetlands would be permitted. Operations are not affected by this stipulation.

Gray Wolf

Prior to construction in potential gray wolf habitat, surveys would include specific searches for this animal, occupied dens, or scat. The corridor would be surveyed in the spring, prior to construction, by a wildlife biologist for scat. If scat is found, the site would be surrounded by a buffer zone recommended through consultation with an FWS biologist. If wolves or other wolf indicators are found, FWS would be consulted and proper protocols followed.

Canada Lynx

Any construction areas or drilling pads located in high elevation, old growth forested areas, especially areas with populations of hares or rabbits, would be surveyed prior to construction for scat and individuals following established protocols. If found, the site would be avoided and surrounded by a buffer zone recommended by FWS biologists.

Black-Footed Ferret

Implementation of stipulations in potential and occupied habitat would avoid impacts to the ferret on BLM land.

Grizzly Bear

Garbage and other human refuse would be removed from drilling and construction sites on a daily basis in potential bear habitat to avoid attracting bears. Surveys for scat and other sign of grizzly bears in remote, sparsely roaded areas would be conducted prior to construction. If found, protocol would be established after consultation with FWS biologists.

Black-Tailed Prairie Dog

Development of mitigation measures for the prairie dog depends upon the recommendations being developed in the previously mentioned Prairie Dog Conservation Plan. This plan would address how to avoid continuing impacts.

Conclusions

Agency-applied mitigation measures would reduce erosion potential and facilitate reclamation of disturbed lands during abandonment. If a state or private CBM project triggers a federally related action, the FWS would need to be consulted for federally protected species, by the Federal agency.

Stipulations would avoid some impacts for certain species. However, they would not be 100 percent effective because of limits on available biological information, some stipulations do not apply to operations, and non-CBM human activities that would be facilitated by new CBM roads. The potential for impacts is relatively low under Alternative A compared to the other alternatives because of the limited number of CBM wells. Natural resource mitigation measures (Table MIN-5, Minerals Appendix) generally focus on vegetation reclamation and related efforts to reduce erosion and water pollution. Measures intended to reduce surface disturbance in sensitive habitats are to be implemented "to the extent practicable." Therefore, it is likely that some sensitive habitats and species could be directly impacted by CBM development under Alternative A. The intent of reclamation is to re-establish a vegetative cover on disturbed areas rather than to restore native plant communities as they existed prior to disturbance. Plant species diversity would be lower on reclaimed sites than before disturbance, reducing overall wildlife habitat values. Existing mitigation measures would not effectively compensate for indirect impacts on wildlife.

Some wildlife species of concern and their preferred habitat may be disturbed or lost during construction. Individual animals may be lost through collisions with vehicles and indirect impacts as described previously for general wildlife. Indirect impacts to species of concern also could result in displacement or abandonment of habitat or to increased poaching pressure. Species of concern on all lands do not have the same level of protection as ESA-protected species. Therefore, some direct and indirect impacts on individuals or even populations within metapopulations would be expected. This alternative would have the least impact on all species of concern because of the limited number of wells and minor (500 long-term acres) associated disturbances.

If habitat degradation is kept at a minimum, mitigation measures are followed for all listed species of wildlife, and appropriate surveys are conducted prior to construction to ensure that these species are not found within or near well sites and other project facilities and corridors and, if found, are buffered by suitable no construction zones and work restrictions recommended by FWS biologists, federally listed wildlife species would be affected but are not likely to be critically affected, directly, by this alternative. For the life of the permit and afterward if road reclamation is not required, these species would be detrimentally affected because of increased road density and associated human activity.

There could be some displacement of bald eagles in non-nesting habitat. Black-tailed prairie dogs would be impacted by this alternative in all dog towns where CBM development occurs within or adjacent to the town. This includes towns less than 80 acres and larger towns if no black-footed ferrets are present.

All species of concern that are not federally protected may be impacted by habitat changes caused by vegetation removal, changes in vegetation species composition after reclamation, increased access because of more roads, increased noise levels, and conflicts with CBM infrastructure and increased human pressure. Changes in stream or spring hydrology and increased SAR and salinity values in water and soil could also have adverse impacts.

Cumulative Impacts

The cumulative impacts on wildlife resulting from the effects of Alternative A include the direct loss of wildlife habitat, habitat fragmentation, and wildlife mortality from collisions. Noise and human presence would disturb sensitive wildlife species over large areas near developed well fields, causing local population declines for some species. This would be particularly problematic for sensitive species such as raptors, sage grouse, and other birds dependent on sagebrush habitats.

Impacts from Wyoming CBM development on wildlife and wildlife habitat would be similar to those described under Alternative A, but at a far larger scale. More than 2.5 times as many CBM wells may be developed in the Powder River basin of Wyoming than the 18,300 considered under Alternatives B, C, D and E. The magnitude of direct and indirect Wyoming CBM impacts on wildlife and wildlife habitat would be about 2.5 times greater than described for Alternatives B, C, and D (described in the following sections). CBM development in Wyoming would have cumulative effects for many species of concern in

Montana, especially under two categories: groundwater and surface water. There would be an increased flow and slight alteration in SAR values in the Powder, Little Powder, and Tongue rivers in Montana (See *Hydrology* section for specific changes). The SAR in the Tongue river is currently 0.86 to 1.36, based on the minimum monthly mean flows. Under Alternative A, it would be 1.93 to 2.52. This is not expected to be enough to cause any major changes in vegetation because most plants are not affected until the SAR exceeds 3 and some cases not until it exceeds 12.

The increase in water volume at certain times has the potential to cover sand bars and other open areas. There would be potential cumulative impacts for bald eagles and interior least tern that are present in these rivers as well because flow fluctuations and alterations in SAR values could affect the food chain these species rely on and because it may affect their nesting habitat.

Cumulative impacts of other activities, including conventional oil and gas, active coal mines, and fires are expected to result in the long term loss of an additional 37,000 acres. Indirect impacts on wildlife would be similar to those described above and would affect an area much larger than 37,000 acres. Some impacts on sensitive and protected species would be expected from development on this scale.

Alternative B—Emphasize Soil, Water, Air, Vegetation, Wildlife, and Cultural Resources

Generally, the same types of impacts on wildlife described for Alternative A would occur under Alternative B. However, Alternative B includes development or the drilling of 18,300 CBM wells. This is about 20 times as many wells; miles of roads, pipelines, and utility corridors, and facilities and 20 times more human activity than for Alternative A. It is important to recognize that the development would take place over a 20-year period and that the initiation of well development (20 times) would not occur all at once. However, production at any given well is expected to continue for 20 years so there would be substantial overlap between wells developed early and those developed later in the 40-year time frame between development of the first wells and closure of the last ones. Because of this level of CBM development, Alternative B would have widespread ecosystem-level types of impacts on wildlife and wildlife habitat as discussed at length for Alternative A.

Virtually every wildlife species that occurs within CBM development areas would be impacted to some degree, with sensitive species suffering the greatest impacts because of their already precarious status. For example, wintering and nesting sage grouse and nesting golden eagles would be expected to suffer large-scale impacts. It is likely that, at this scale of development, some species would become locally rare or vacate large areas. All of the wildlife groups listed in Table 4-56 would have a very high probability of being impacted throughout the CBM development area under Alternative B because of the scale of the development.

Table 4-54 in the Vegetation section notes the number of acres of direct impact (habitat loss) and the number of miles of roads, pipelines and utility corridors that would result from CBM development under Alternatives B, C, D, and E. Development under Alternative B would result in the direct short term loss of about 55,400 acres of wildlife habitat to well pads, roads (6,680 miles), and pipeline and utility corridors (20,679 miles). Long term impacts would persist on about 33,000 acres after reclamation of exploration disturbance. However, as noted for Alternative A, plant species diversity would be lower on reclaimed lands than before disturbance, resulting in reduced habitat value for many species and habitat fragmentation for some species. Additional vegetation would be disturbed by multiple exploration vehicles moving across the landscape searching for suitable locations to drill exploratory wells. Direct and indirect impacts on wildlife from this scale of development would be widespread.

The discussion of impacts for Alternative A indicated that elk, sage grouse, raptors, and other species are particularly sensitive to human disturbance associated with CBM development and related roads. Not all wildlife species are as sensitive to roads and disturbance as these species. However, those that are the most sensitive often include species that are declining in numbers and distribution because of this sensitivity, such as sage grouse and many raptors, including ferruginous hawks (*Buteo regalis*). Table 4-57 provides estimates of the area of habitat within which species sensitive to disturbance and roads may be affected both within and around the perimeter of CBM well fields. Potentially affected areas are estimated for both 1/2-mile and 2-mile perimeters around well fields and related activity (Fyfe and Olendorff 1976, Lyon 1983, Connelly et al. 2000).

TABLE 4-57
AREA OF DIRECT IMPACTS AND INDIRECT WILDLIFE DISTURBANCE AND DISPLACEMENT[1] WITHIN AND AROUND CBM WELL FIELDS FOR MORE SENSITIVE WILDLIFE SPECIES FOR ALTERNATIVES B, C, D, AND E

(ASSUMES 200 WELLS PER WELL FIELD, 8, 16, OR 24 WELLS PER SQUARE MILE[2])

		Indirectly Affected Area Within 1/2 Mile		Indirectly Affected Area Within 2 Miles	
Number of Wells Per Square Mile	Acres Per Well Field	Additional Area Affected Around Perimeter of Each Well Field	Total Affected Area Within Well Fields and Within 1/2 Mile of Well Field Perimeters[3]	Additional Area Affected Around Perimeter of Each Well Field	Total Affected Area Within Well Fields and Within 2 Miles of Well Field Perimeters[3]
		Acres	Acres	Acres	Acres
Alternatives B, C, D, and E—18,300 Wells and 91.5 Well Fields					
8	16,000	7,040	2,108,160	35,840	4,743,360
16	8,000	5,120	1,200,480	28,160	3,308,640
24	5,312	4,352	884,256	25,152	2,787,456
Cumulative Impact of CBM Development Only for Alternatives B, C, D, and E—26,500 Wells and 132.5 Well Fields					
8	16,000	7,040	3,052,800	35,840	6,868,800
16	8,000	5,120	1,738,400	28,160	4,791,200
24	5,312	4,352	1,280,480	25,152	4,036,480

[1]See text for discussion of individual and population level consequences of displacement.

[2]A larger average number of wells per field would reduce the affected area. For example, fields averaging 1,000 wells per field and 8 wells per square mile would impact 1,738,061 acres instead of 2,108,160 acres.

[3]Affected area around well fields assumes there is no overlap between affected areas of adjacent well fields. Overlap would reduce affected perimeter area.

Table 4-57 assumes that well field development would include 8, 16, or 24 wells per square mile and that each well field would include 200 wells. CBM well development is projected to occur over a 20-year period with an average well life of 20 years. Therefore, the information presented in Table 4-57 represents the maximum area of disturbance for sensitive wildlife species in year 20 when all wells would be developed and none would have been closed. Approximately 44 percent of the wells and associated disturbance would be in place in year 5, 72 percent in year 10, and 87 percent in year 15. By year 20, indirect impacts of CBM development would affect sensitive species of wildlife on between 880,000 and 4.7 million acres. Sagebrush obligate song birds, which are suffering range-wide population declines, are also sensitive to disturbance and habitat fragmentation. They avoid pipeline and road corridors even when the roads are unpaved and receive little use (Ingelfinger 2001). His research in Wyoming natural gas fields found that the density of sagebrush obligates including Brewer's sparrow (*Spizella breweri*), sage sparrow (*Amphispiza belli*), and sage thrasher (*Oreoscoptes montanus*) were reduced by 50 percent within 100 meters of lightly traveled unpaved roads compared to densities in undisturbed sagebrush communities. Sage sparrow density along a natural gas pipeline route with no traffic was 64 percent lower within 100 meters of the route compared to densities in nearby undisturbed sagebrush. Ingelfinger (2001) attributed these declines to noise (along the roads), habitat fragmentation, edge avoidance, and possibly inter-specific competition with horned larks, a species that forages along roads. At full development there would be 6,680 miles of new roads. Assuming no overlap, 100 meters on each side of these roads would include over 530,000 acres and additional effective habitat loss would occur along pipelines. These lands are included in the information presented in Table 4-57.

Some additional direct and indirect impacts not already described for Alternative A would be expected to occur under Alternative B because of the much greater scale of CBM development. Prairie dog colonies tend to be located on relatively flat ground, and often in valleys. Prairie dog towns also support much higher densities of birds and mammals and greater avian species richness than adjacent prairie (Agnew et al. 1986). Various studies have reported 163 vertebrate species using black-tailed prairie dog colonies in Montana including several species of concern such as burrowing owl and mountain plover (Reading et al. 1989, Tyler 1968, Clark et al 1982, Agnew 1986). Prairie dog colonies larger than 80 acres are protected from surface occupancy only if black-footed ferrets are found and this protection applies on BLM lands only. Smaller colonies and larger colonies without ferrets would effectively receive no special protection on any lands. Considering the ferrets extreme rarity, it is unlikely that any prairie dog towns would be protected from impacts from CBM development. Road, well pad, pipeline, and utility line placement across and on prairie dog towns would result in direct mortality and impact large numbers of species through habitat loss and displacement to unsuitable habitat, which would result in the loss of displaced individuals.

As discussed in the Hydrological Resources section, surface water bodies would not be impacted directly from groundwater withdrawal due to the depth and confined nature of the individual coal seams. In the very unlikely event that there is a very localized connection between a spring-fed stream and groundwater withdrawals, effects on wildlife and habitat would include reducing or even drying of springs, and reduced flow and duration in intermittent and small perennial drainages. Reduced surface water would result in more xeric vegetation and would impact all types of wildlife, but would be especially important for amphibians and certain bird species that depend on mesic plant communities. Sage grouse could suffer substantial impacts because broods spend much of July and August in more mesic sites as sagebrush habitats desiccate (Gill 1965, Savage 1969, Connelly and Markham 1983, Fischer et al. 1998). Reduced availability of mesic sites would reduce sage grouse brood survival and unfavorably affect populations (Connelly et al. 2000).

There would be no differences between the direct and indirect impacts on BLM and state lands. Impacts on private lands could be much more substantial because stipulations and mitigation measures would not apply.

Federally Listed Species

Direct impacts to federally protected species are prohibited by law and would be the same as under Alternative A.

The potential for indirect impact would be greater under this alternative because of the much larger amount of habitat that would be disturbed or lost with the increased level of vegetation disturbance associated with the greater number of well pads, roads, and utility lines. Increased roadways for more wells would result in greater human access, with the potential for more poaching, indirect disturbance, or harassing of protected species. As many as 4.7 million acres of habitat for species sensitive to human disturbance may be indirectly affected by CBM development (Table 4-57). Since federally listed species are often rare because of their sensitivity to human disturbance, it is

unlikely that all potential indirect impacts would be avoided.

The same agency-applied mitigation measures described for Alternative A would apply to Alternative B. The effect of these mitigation measures on impacts would also be the same as under Alternative A.

Crow Reservation

Indirect impacts on the Crow Reservation would be similar to those described in general for Alternative B and be the result of developments in close proximity to reservation boundaries.

Regulations related to wildlife would be under the jurisdiction of Tribal Laws and not state or federal laws. Exceptions to these impacts would include disruption of migratory pathways of some wildlife, impacts resulting from vehicular traffic, hunting of wildlife, and noise and other impacts to wildlife near borders of the reservation. Full-scale development forecast under this alternative would increase the risk of these kinds of impact to wildlife on the reservation.

Wildlife vulnerability to impacts would be similar to that presented in Table 4-56. Indirect impacts of this level of CBM development on the Crow Reservations on species sensitive to human disturbance are shown in Table 4-57 under cumulative impacts.

Northern Cheyenne Reservation

There would be no direct impacts to wildlife on the Northern Cheyenne Reservation from off-reservation development. Indirect impacts on the Northern Cheyenne Reservation would be similar to those described in general for Alternative B and be the result of developments near reservation boundaries.

Conclusions

The same types of impacts described for wildlife and species of concern under Alternative A would be expected. However, the extent of impacts would be about 20 times greater in area and scope because of greater CBM well development and associated direct and indirect impacts. Stipulations would avoid some impacts for certain species. However, they would not be 100 percent effective because of limits on available biological information, some stipulations do not apply to operations, and non-CBM human activities that would be facilitated by new CBM roads. The potential for impacts is high under Alternative B because of the large number of CBM wells.

Cumulative Impacts

Cumulative impacts would be similar to those described for Alternative A except that the impacts from Montana CBM development would be substantially greater. Additional CBM development on the Crow and Northern Cheyenne Reservations and in the Custer National Forest is expected to result in the direct short-term loss of an additional 25,000 acres and long term loss of about 14,750 acres. Degraded habitat value of reclaimed lands would be similar to that described for Alternative A. Other actions considered to be cumulative impacts would result in the long term loss of an additional 37,000 acres.

Table 4-55 estimates additional cumulative indirect impacts of more CBM development on species sensitive to human activities and development. It is estimated cumulative indirect impacts of CBM development in Montana could affect sensitive wildlife on between 1.28 and 6.87 million acres. Since sensitive and federally listed species are often rare because of their sensitivity to human disturbance, it is unlikely that all potential indirect impacts would be avoided.

Alternative C—Emphasize CBM Development

The same types of impacts on wildlife described for Alternatives A and B would occur under Alternative C. However, Alternative C would have direct impacts on more acres of wildlife habitat than Alternative B because Alternative C includes fewer measures to reduce impacts. Table 4-54 in the *Vegetation* section notes the number of acres of direct impact (habitat loss) and the number of miles of roads and pipeline and utility corridors that would result from CBM development under Alternative C. Development under Alternative C would result in the direct short term loss of about 70,000 acres of wildlife habitat to well pads, roads (9,018 miles versus 6,680 miles for Alternative B), and pipeline and utility corridors (27,917 miles versus 20,679 miles for Alternative B). More land would be directly impacted because roads would not be required to follow existing corridors and there would be no requirement to place pipelines and utilities in corridors. Long term habitat loss would affect about 47,600 acres and reclaimed areas would have reduced habitat value. Direct and indirect impacts on wildlife from this scale of development would be widespread.

Table 4-57 estimates the area on which sensitive species of wildlife would be disturbed by CBM development under Alternative C. Indirect disturbance and effective habitat loss for sensitive species would

be the same as under Alternative B and would indirectly affect sensitive wildlife on between 880,000 and 4.7 million acres. Effects of disturbance were described under Alternative A.

CBM development produces excess surface water that has not been available in the past. It is unlikely that this water would go unused. Information in the *Water Resources Technical Report* (ALL 2001b) indicates that virtually all of the water produced during CBM extraction would be suitable for livestock or wildlife use. Cattle typically move up to 0.6 mile from water to graze in steep terrain, but will move up to 2 miles in relatively flat areas (Stoddart et al. 1975). CBM development areas that are greater than 0.6 to 2 miles from natural or currently developed perennial water sources, depending on terrain, are either not used or used lightly by livestock on a seasonal basis. Increased stock water availability from CBM-produced water would permit private land owners and state and BLM grazing permittees to adjust the distribution and management of their herds to use more of the forage within 0.6 to 2 miles of CBM wells. Each CBM production well field that is located in an area without current perennial water sources could make up to several thousand acres available to more intensive cattle grazing. Utilization would be most intensive in the immediate vicinity of the water discharge location wells. Increased livestock grazing reduces forage otherwise available for wildlife and degrades habitat value for many species of wildlife (Saab et al. 1995). The additional CBM water would also be available for wildlife use.

The release of untreated CBM water to surface drainages and streams could result in serious erosion, damaging or destroying instream and stream bank riparian vegetation that constitutes valuable wildlife habitat (Regele and Stark 2000). The erosion can result in increased sediment loads, which along with the potential high salinity and sodicity, can degrade the stream and impact riparian vegetation. Impacts of discharging sodic CBM waters would likely be greatest in intermittent and smaller perennial drainages during low-flow periods. Releases during low-flow periods of late summer and fall would have the greatest potential to impact riparian habitat and sensitive wildlife species such as amphibians. This is also the time when this vegetation is naturally stressed because of low water and amphibians are confined to remaining water or are burrowed into shallow mud. The potential for impacts on riparian habitat and amphibians exists along drainages and streams throughout the CBM development area.

Because of the typically low flows of the CBM wells (approximately 5 to 10 gallons per minute), it is likely that these impacts would be localized in the vicinity of the discharge, unless flow were collected from a large number of wells, which may occur. There are no apparent differences between the direct and indirect impacts on BLM and state lands. Impacts on private lands would be much more substantial because stipulations and mitigation measures would not apply.

Species of Concern

Direct impacts to federally protected species are prohibited by law and are the same as under Alternatives A and B.

The potential for indirect impacts or modification to habitat would be greater under this alternative than for Alternative B (Table 4-57) because fewer potential impacts would be avoided. Reclamation of disturbed areas would not necessarily restore sites to previous habitat configurations or specific habitat needs of listed species. This alternative would have the greatest acreage of disturbance from roadways, pipelines, and utilities of any alternative. Power line strike hazards are highest with this alternative. This alternative may affect SAR levels in rivers that would affect BLM and state species of concern and bald eagle foraging, interior least tern foraging success, and nesting habitat. Production water disposal could also develop riparian areas that would be lost after abandonment. If listed species come to rely on these areas of developed habitat, this would lead to future declines when the water source for them no longer exists.

Crow Reservation

Impacts to the Crow Indian Reservation would be similar to the indirect impacts described in general for Alternative C. These indirect impacts would occur in areas adjacent to off-reservation CBM developments.

Northern Cheyenne Reservation

Since there is no Tribally sponsored CBM development impacts to the Northern Cheyenne Reservation would be similar to the indirect impacts described in general for Alternative C. These indirect impacts would occur in areas adjacent to off-reservation CBM developments.

Conclusions

The same types of impacts described for Alternatives A and B for wildlife and the same as described for Alternative B for sensitive species would be expected. However, impacts would be at a greater level due to the emphasis on CBM production under Alternative C. Approximately 21,000 more acres would be directly

impacted in both the short and long term compared to Alternative B.

Cumulative Impacts

The types of cumulative impacts would be the same as described for Alternatives A and B. CBM development is expected to result in the direct short and long term loss of an additional 21,000 acres compared to Alternative B. Degraded habitat value of reclaimed lands would be similar to that described for Alternative A. Other actions considered to be cumulative impacts would result in the long term loss of an additional 37,000 acres.

Table 4-57 estimates additional cumulative indirect impacts of more CBM development on species sensitive to human activities and development. It is estimated cumulative indirect impacts of CBM development in Montana could affect sensitive wildlife on between 1.28 and 6.87 million acres. Since sensitive and federally listed species are often rare because of their sensitivity to human disturbance, it is unlikely that all potential indirect impacts would be avoided.

Alternative D—Encourage Exploration and Development While Maintaining Existing Land Uses

The same types of direct and indirect impacts on wildlife described for the Alternatives A and B and in Tables 4-56 and 4-57 would occur under Alternative D. Areas affected by direct and indirect impacts would be similar to those reported for Alternative B with the additions noted below. The impacts of the beneficial use of water for livestock grazing described for Alternative C would also occur under Alternative D. Unlike Alternative C, CBM water discharged under Alternative D would be treated before release. Additional treated water provided to intermittent and small perennial streams may result in both impacts and benefits, depending mostly on the volume of discharge water relative to the natural flow, the steepness of the terrain, and the erosiveness of the soil. Relatively high volumes of water discharged into smaller drainages could erode the channel, destroying riparian vegetation either directly or as a result of channel down-cutting, which would reduce water availability to plants. Intermittent water sources that become perennial because of CBM discharge would attract grazing livestock for longer periods of the year, resulting in degraded range conditions and reduced forage and cover for wildlife. Increased flows may also result in improved and more extensive riparian vegetation in intermittent drainages where seasonal water stress limits the current extent or condition of the vegetation and in more widespread water availability for wildlife. However, this benefit would be offset if more livestock grazing occurs in the vicinity and downstream of the discharge points. Lack of a requirement to reclaim roads and abandoned reservoirs would increase the potential for noxious weed occurrence and resulting habitat degradation.

There are no apparent differences between the types of direct impacts on BLM or state lands. Furthermore indirect impacts would have very little difference between BLM and state managed lands. Impacts on private lands would be much more substantial because stipulations and mitigation measures would not apply.

The same agency-applied mitigation measures described for Alternative B would apply to Alternative D. The effect of these mitigation measures on impacts would also be the same as under Alternative B.

Species of Concern

Direct impacts to federally protected species are prohibited by law and are the same as under Alternative A. The potential for indirect impacts or modification to habitat would be greater under this alternative than Alternatives A or B, but less than Alternative C. As with those alternatives, reclamation of disturbed areas would not necessarily restore sites to previous habitat configurations or specific habitat needs of listed species. There would be increased roadways with this alternative over either Alternatives A or B. As with Alternative C, production water disposal, which would be treated under this alternative, could develop riparian areas that would be lost following abandonment.

Mitigation is the same as for Alternative B.

Crow Reservation

Indirect impacts on the Crow Reservation would be similar to those described in general for Alternative B. However, since there would be no Tribal sponsored development, impacts would be limited to adjacent boundaries from off-reservation development. Small areas of private development on the reservation would cause direct impacts similar to those described in Alternative D, but adjusted for the limited scale of development.

Northern Cheyenne Reservation

Indirect impacts on the Northern Cheyenne Reservation would be similar to those described in general for Alternative B and are expected to occur in

areas adjacent to off-reservation development. No Tribal sponsored CBM development is anticipated for this alternative and therefore no direct impacts to wildlife are expect to occur on the Reservation.

Conclusions

Direct, indirect, and residual impacts on wildlife would be similar to those described for Alternative B.

Under all alternatives, the variety of life forms and the large number of species of concern, the lack of specificity of project locations, and the wide variation in habitat used by these species preclude the ability to identify specific impacts to each individual species of concern. Exploration and development of CBM wells would result in a variety of direct and indirect impacts to species of concern. Specific impacts would depend on the species, the amount and type of habitat removed, and the nature and period of disturbance. Leasing stipulations as discussed above would reduce or avoid some impacts to federally listed and other sensitive species. However, there are no stipulations for most species of concern.

Cumulative Impacts

Cumulative impacts would be similar to those described for Alternative B.

Alternative E—Preferred Alternative

The types of impacts on wildlife under Alternative E would be similar to those described in Alternative A. However, the magnitude of the impacts would be substantially higher because the level of development would be much higher, as shown on Table 4-57. Examples of types of impacts similar to Alternative A follow:

- Direct habitat loss and direct and indirect impacts because of habitat disruption and wildlife disturbance caused by roads, pipelines, and utility corridors would cause the bulk of the impacts on wildlife.
- Direct impacts would include loss of habitat to accommodate project features. They would persist for the duration of CBM activities and, in the case of loss of habitat value, beyond that time. Some degree of habitat loss and degradation would continue following CBM abandonment because of ecological differences between reclaimed sites and native vegetation.
- Based on the average area expected to be disturbed by exploration and development of each CBM well, Alternative E would result in the direct disturbance of 73,860 acres resulting from development of 18,300 wells, 9,018 miles of roads, and 27,917 miles of utility corridors (Table 4-54). Direct impacts on wildlife would also include mortality as relatively less mobile small mammals, reptiles, and amphibians are killed during road and other site construction. Smaller mammals, reptiles, and amphibians are most likely to be directly killed by vehicles and are vulnerable when crossing roadways (USDI and USDA 2001).
- Additional direct impacts would occur on private lands because state and federal lease stipulations are recommended but not required.
- Table 4-56 indicates the relative level of vulnerability of different representative types of wildlife to direct and indirect impacts. Most indirect impacts on wildlife would occur during all CBM phases on BLM, state, and private lands. The duration of effects would correspond with the duration of each phase and the intensity of activity during that phase. The relative magnitude of impacts would be directly related to the nature and extent of activities associated with each phase of CBM development. Some indirect effects would persist beyond abandonment because continued human use of some CBM and user-created roads that are not closed and reclaimed (USDI and USDA 2001).
- Table 4-57 provides estimates of the area of habitat within which species sensitive to disturbance and roads may be affected both within and around the perimeter of CBM well fields. Potentially affected areas are estimated for both 1/2-mile and 2-mile perimeters around well fields and related activity (Fyfe and Olendorff 1976, Lyon 1983, Connelly et al. 2000). The information presented in Table 4-57 represents the maximum area of disturbance for sensitive wildlife species in year 20 when all wells would be developed and none would have been closed. By year 20, indirect impacts of CBM development would affect sensitive species of wildlife on between 880,000 and 4.7 million acres. Species sensitive to indirect impacts at this scale were discussed under Alternative A.
- Overhead power lines constructed for production wells pose problems for a variety of wildlife species. Raptors and other species of birds occasionally collide with power lines, especially during periods of relatively poor visibility. Overhead power lines can benefit some raptors in open country by providing hunting perches.

However, the additional perches also result in local population declines in prey species. For example, overhead power lines constructed in the vicinity of sage grouse and sharp-tailed grouse leks and wintering areas can substantially increase predation rates on the grouse. The risk of raptor electrocution on federal and state lands is very small because the BLM and State would require that all power lines and poles be constructed to standards that would avoid raptor electrocution. Raptor and sage grouse collisions with power lines have also been noted throughout the west including eastern Montana.

- Stipulations prohibit surface occupancy in riparian areas and on floodplains of major rivers. However, they do not prohibit crossing of streams or construction of roads through riparian areas. Roads constructed through riparian areas and other forest and shrub stands for CBM development and operation create edge effects and alter the physical environment (Trombulak and Frissell 2000). Roads create drier conditions in the vicinity of the road, thereby altering habitat for many species. In grassland and shrubland habitats, trails and roads create edge habitat for predators and reduce patch size of remaining habitat for area-sensitive species (USDI and USDA 2001, Ingelfinger 2001). Swihart and Slade (1984) found that prairie voles (*Microtus ochrogaster*), which occur in the EIS planning area, were reluctant to cross tire tracks running through an open field. Reluctance to cross narrow gravel roads has also been observed in white-footed mice (*Peromyscus leucopus*), which also occur in the EIS planning area, and many other rodent species (Mader 1984, Merriam et al. 1989, Oxley et al. 1974). Consequently, roads can function as barriers to population dispersal and movement for small mammals that occur in the EIS planning area.

- The assumption is made that existing stipulations would provide some protection to sage grouse habitat including lek areas, nesting habitat and winter range. It is recognized that these actions would not completely protect this species. Mitigation measures within the Wildlife Monitoring and Protection Plan (WMPP) will provide additional protective measures. Lease stipulations and terms and conditions would provide protection to raptors and the mountain plover. Protective measures contained in the WMPP (if fully implemented) would help reduce, but cannot avoid all, impacts to all species of wildlife including sagebrush-obligate birds.

See Alternative A for a complete discussion of the types of impacts on wildlife expected from CBM development, including impacts on threatened and endangered and candidate species.

The magnitude of impacts would be somewhat less severe than expected under Alternatives B, C, or D because of implementation of the Wildlife Monitoring Protection Plan (WMPP), which is located in the Wildlife Appendix. Project Plans would be developed and approved using the programmatic guidance outlined in the WMPP. They would include baseline inventory for sensitive wildlife and habitats in areas where such inventories have not been completed. Certain broad landscape level inventories would be conducted by the BLM. The BLM or Operators would conduct additional, more detailed inventories and monitoring. Operators would be required to submit plans that demonstrate how their project design minimizes or mitigates impacts to surface resources and meets objectives for wildlife before exploration and approval of the APD. The WMPP would be a cooperative approach that incorporates adaptive management principles to try to deal with impacts as they occur. The Plan also establishes a framework that encourages industry, landowners, and agencies to work together constructively to incorporate conservation measures into CBM development. All CBM development would follow the programmatic guidance to address wildlife concerns, and each individual Project Plan would include a site-specific Monitoring and Protection Plan which includes mitigation specific to species or local habitats. Over the life of the CBM project, monitoring and evaluation through area specific WMPPs would offer some insight as to the effectiveness and failures of management actions, and therefore encourage adaptive strategies to address specific and unforeseen problems.

Some examples of how the WMPP would be applied are described below. It must be recognized however, that because of the scale of CBM development proposed under this alternative, it would only be possible to reduce or lessen impacts to important wildlife habitats utilizing measures described in the WMPP.

As discussed in alternative A, the primary objective of reclamation is to restore vegetative cover to the disturbed site. While present required seed mixes include native species, restoration to near-native conditions is not achievable. However, flexibility provided by the WMPP allows for more creative options in reclamation plans to restore important wildlife habitats. An example would be to focus on restoration of sagebrush stands on big game winter

ranges as opposed to establishing a herbaceous cover only.

As part of the approval process for project protection plans, location and use of roads would be a very high focus. Project design would include locating roads in such a manner as to avoid crucial areas within big game and sage grouse winter ranges (i.e. south facing slopes, sagebrush flats and valley floors), raptor nesting areas and prairie dog towns. Additionally, stipulations may be applied that preclude use of these roads during critical time periods of the year (seasonal restrictions) or day (timing restrictions) that would apply to all CBM activities.

The power infrastructure associated with CBM development is identified as a major wildlife impact. Agencies already require all powerlines to be raptor proof according to accepted standards. However, additional stipulations may be required based on site specific needs. Examples of this may be locating powerlines away from sage grouse leks and winter concentration areas, burying powerlines in critical areas and applying more aggressive raptor-proofing options than previously required. .

Mandatory mitigation measures are listed in Chapter 2.

Species of Concern

The types of direct and indirect impacts would be similar to Alternative A. This alternative would have more impact on all species of concern because of the increase in number of wells and their associated disturbances.

In accordance with the ESA, federal agencies must consult with US Fish and Wildlife Service (USFWS) if a federal action may affect a federally listed species. The USFWS has offered a Biological Opinion (BO) located in the Wildlife Appendix addressing impacts to wildlife species protected under the ESA and described in the Biological Assessment (BA) (Wildlife Appendix). The BA determined that the preferred alternative posed the potential for "take" of individual animals or habitat for both the bald eagle and mountain plover. Mandatory terms and conditions were included in the BO to reduce the likelihood of take and exempt BLM from Section 9 of ESA through a incidental take statement.

The magnitude of impacts for these species would be less severe under this alternative than other expanded development alternatives because of the mandatory implementation of Terms and Conditions (T&C) prescribed in the USFWS BO (Wildlife Appendix). Other listed species that occur in the planning area addressed in the BA and BO and were determined as "not likely to be adversely affected" by CBM developments.

The assumption is that these same T&Cs would offer some degree of protection to other species associated with bald eagles and mountain plover habitat. An example of this is as follows:

> Due to the declining status of mountain plover in the analysis area and the plover's attraction to prairie dog towns, all active black-tailed prairie dog colonies within suitable mountain plover habitat would have No Surface Occupancy (NSO) to protect this important and limited plover nesting habitat. This NSO would be applied only to federally managed surface acres.

In addition to prairie dogs, other associated species including burrowing owl, ferruginous hawk and many other species would benefit from this action. T&Cs addressing surface use, roads, powerlines modifications and surface occupancy would ultimately provide benefits to species other than mountain plovers and bald eagles. For example, power line avoidances and installation of anti-perching devices in high avian use areas such as wetlands, prairie dog towns and grouse leks would not only protect bald eagles and other raptors but also the prey species associated with those habitats.

Additionally, there are many species classified as "BLM sensitive species or special concern" by the Montana BLM and MNHP. These include 68 plant, 16 mammal, 6 herptile, and 22 bird species. By policy, BLM management cannot impact these species in a way that may cause further declines in the species' population status and lead to a federal listing. Because changes in a species' status under the ESA are based on range-wide variables, it is very difficult to identify a particular threshold as to when that species' status would change to threatened or endangered. Implementation of conservation measures described in the WMPP and monitoring of populations of special status species would give us the ability to reduce impacts to individuals and detect changes in population status allowing us to make adjustments in management. Therefore it is reasonable to assume the BLM policy 6840 for special status species would be met.

Impacts on species of concern are discussed under Alternative A. The WMPP addresses guidance for developing Plans of Development. Project Plans and conservation measures applied as Conditions of Approval provide a full range of practicable means to avoid or minimize harm to wildlife species or their

habitats. Operators would minimize impacts on wildlife by incorporating applicable WMPP programmatic guidance into Project Plans. Not all measures may apply to each site-specific development area and means to reduce harm are not limited to those identified in the WMPP. BLM and MFWP would work together through a Cooperative Agreement to collect baseline information about wildlife and sensitive habitats possibly containing special status species.

The WMPP is intended to reduce potential impacts on a variety of sensitive species by requiring inventories prior to exploration. This action would likely reduce potential direct impacts on sensitive species and may also reduce potential indirect impacts in some cases. However, given the scale of CBM development, it is very unlikely that all direct and indirect impacts on species of concern can be avoided. Monitoring findings may result in additional conditions of approval and mitigation measures for CBM development that occurs after initial monitoring data are collected and analyzed, which could further reduce, but not eliminate, potential impacts on sensitive species.

Crow Reservation

Indirect impacts on the Crow Reservation would be similar to those described in general for Alternative E. Impacts would be limited to adjacent boundaries from off-reservation development.

Northern Cheyenne Reservation

Indirect impacts on the Northern Cheyenne Reservation would be similar to those described in general for Alternative A. Specific mitigation measures proposed by the Northern Cheyenne Tribe that would be implemented by the BLM are described in the Northern Cheyenne Mitigation Appendix.

Conclusions

The types of direct, indirect, residual, and cumulative impacts would be generally the same as those noted for Alternatives A and B. Discharge of treated water to intermittent and small perennial streams would result in both impacts and benefits to aquatic/riparian vegetation, amphibians, aquatic wildlife and invertebrates; depending mostly on the volume of discharge water relative to the natural flow.

Direct, indirect, and cumulative habitat loss, wildlife disturbance and mortality, and poaching would be greater with this alternative than either Alternatives A or B because of the greater area of disturbance from the increased level of well development (Table 4-54). The magnitude of direct impacts would be greater than those of Alternatives B, C, and D (Table 4-54). Indirect and cumulative impacts would be similar to those of Alternatives B, C, and D (Table 4-57). Implementation of the WMPP would reduce direct and indirect impacts.

All species of concern that are not federally protected would be impacted by habitat changes caused by vegetation removal that are not fully recovered with reclamation after well abandonment, by increased access through increased roads, or by changing streambed hydrology.

Cumulative impacts would be similar to those described for Alternatives A and B.

Aquatic Resources

Wildlife (Aquatic Resources) ***Fish species vary between watersheds within the CBM emphasis area from 8 in the Little Big Horn River to 32 in the Musselshell River.*** *Special Status Aquatic Species: Montana Arctic grayling, Pallid sturgeon, and Warm spring zaitzevian riffle beetle*
Alternative A **No Action (Existing CBM Management)**
• Minor short-term impacts on aquatic resources during CBM exploration and production may result from increased sediment delivery and its effects on aquatic habitat and organisms, possible impedance of fish movements, potential for accidental spills of petroleum products, and possibly increased fish harvest. • Relatively minor long-term increases in river flow and TDS concentration from production water discharge would not be expected to impact aquatic resources. • Conditions of MPDES Permits would provide legally enforceable assurances that water quality, aquatic resources, and the beneficial uses of receiving waters would not be degraded by production water discharges. • Impacts from CBM abandonment would be minor and subside over time.
Alternative B **CBM Development with Emphasis on Soil, Water, Air, Vegetation, Wildlife and Cultural Resources**
• The same types of impacts described for Alternative A (No Action) would occur under Alternative B, except as noted in the following two bullets. – The scale of potential impacts associated with sediment delivery, fish movements, petroleum spills, and fish harvest would be greater under Alternative B because of the development of over 18,000 CBM wells across a much larger geographic area. – No CBM production water would be discharged to surface drainages under Alternative B. • Based on fish species, fisheries management policies, fisheries resource values, and projected intensity of CBM development, the drainages most sensitive to the effects of CBM development would be the Lower Bighorn, Upper Tongue, and Little Bighorn; then the Lower Tongue, Little Powder, and Rosebud; followed by the Mizpah. • The potential for affecting aquatic resources in sensitive drainages would be less under Alternative B than under Alternatives C or D.

Alternative C Emphasize CBM Development
• The same types of impacts described for Alternative A would occur under Alternative C, but they would occur on a far greater scale because of the development of over 18,000 CBM wells. • A total of 0.67 billion cubic feet of untreated CBM production water would be discharged to drainages each year. Resultant flow and TDS increases could potentially impact aquatic organisms, especially in smaller drainages during dry times of the year. • Conditions of MPDES Permits would provide legally enforceable assurances preventing the degradation of water quality, aquatic resources, and the beneficial uses of receiving waters. • The potential for affecting aquatic resources in the sensitive drainages would be greater under Alternative C than under Alternatives B or D.
Alternative D Encourage CBM Exploration and Development While Maintaining Existing Land Uses
• The same types of impacts described for Alternative A would occur under Alternative D, but they would occur on a far greater scale because of the development of over 18,000 CBM wells. • The annual discharge of 2.24 billion cubic feet of treated CBM production water through pipelines or constructed water courses and resultant flow increases could impact aquatic resources in smaller drainages during dry times of the year. • The treatment of CBM production water prior to its discharge would greatly reduce the potential for elevated TDS and salinity impacts on aquatic resources. • MPDES Permits would provide legal assurances that water quality, aquatic resources, and beneficial uses of receiving waters would be protected. • The potential for affecting aquatic resources in the sensitive drainages would be greater under Alternative D than under Alternative B but less than under Alternative C.
Alternative E Preferred CBM Development Alternative
• Same as Alternative B.

Assumptions

The BLM has identified numerous mitigation measures in Chapter 2 that would be implemented to avoid or minimize impacts on biological resources and hydrological features resulting from CBM exploration, production, and abandonment activities on BLM lands. These measures are common to all of the alternatives being analyzed in this EIS and are derived from current BLM leasing stipulations (contained in Minerals Appendix, Table MIN-5), standard operating procedures and BMPs, and State of Montana field orders. Several of the mitigation measures related to aquatic resources are briefly reviewed here for reader reference prior to discussing potential impacts and impacts that would be avoided or minimized, assuming the successful implementation of these mitigation measures.

A key mitigation measure that directly affects aquatic resources is that the Montana and Wyoming Water Quality Agreement, which is pending final approval, would preserve the current water quality in the Tongue River and prevent Wyoming operators from discharging poor quality production water into the Tongue River. Examples of other mitigation measures related to aquatic resources that are referenced in Chapter 2 and described in Table 4-55 of the Wildlife section include a prohibition on the surface occupancy or use of water bodies and streams, riparian areas, and 100-year floodplains of major rivers, streams, and water bodies. In addition, surface occupancy and use is prohibited within 1/4 mile of designated reservoirs with fisheries to protect the fisheries and recreational values of reservoirs.

Specific mitigation measures are directed at protecting water quality and aquatic resources in drainages by controlling erosion and sediment delivery, particularly on steep slopes and during wet times of the year; minimizing the number of stream crossings; reclaiming, reseeding, and revegetating disturbed areas; and maintaining a Spill Prevention Control and Countermeasures (SPCC) Plan to deal with accidental spills and control storm water run-off. A number of mitigation measures that would be applied on a case-by-case basis, as needed, are described in Appendix Table MIN-5. Examples of mitigation measures associated with aquatic resources, some of which are directed at special status species, include considerations of the location and timing of stream crossings as they relate to fish spawning periods and habitat, and the minimization or avoidance of in-channel activities to reduce the potential for habitat loss. The reader is referred to Chapter 2, Table 4-53, and Minerals Appendix, Table MIN-5 for a complete listing of all mitigation measures.

These mitigation measures would avoid some of the impacts that may otherwise occur on BLM lands in the absence of such measures, but they do not apply to CBM-related activities on non-BLM lands and therefore would not avoid impacts on non-BLM lands. The only management objective that applies to BLM lands and lands subject to state regulations is the required placement of untreated waters from exploration activities in holding pits, tanks, or reservoirs, with no discharge to waters of the United States allowed.

CBM exploration, production, and abandonment activities would potentially impact aquatic resources in a number of ways. The likelihood of these impacts occurring depends on the exact nature, location, and timing of CBM activities; the proximity of CBM activities to water bodies and the presence of sensitive species and/or sensitive life stages in these water bodies; and the nature of mitigation measures that would be implemented to minimize, avoid, or mitigate the potential occurrence of impacts. The success of these actions requires and assumes a site-specific understanding of the resources to be protected and adherence to mitigation measures during CBM activities. The assumptions stated in the Hydrological Resources section of this chapter also form a portion of the framework for analyzing potential impacts from CBM activities on aquatic resources.

The discussion of impacts in the following text for the No Action Alternative first describes the types of impacts that would result from CBM activities in the absence of mitigation measures . It then assesses the likelihood of such impacts occurring based on the nature and magnitude of CBM activities, the proximity of those activities to aquatic resources, and the rigor of mitigation measures that would be implemented on lands managed by BLM and on lands subject to state regulations. Conclusions address the residual impacts that would remain following the implementation of mitigation measures. Conclusions also address the cumulative impacts that would result from the residual impacts of CBM development combined with the potential effects of other projects in the area.

Many of the same types of direct and indirect impacts on aquatic resources would occur regardless of the number of CBM wells developed, although the magnitude of impact would vary. Many of the same types of mitigation measures also would be implemented. Therefore, the detailed discussions of types of impacts first presented for the No Action Alternative are referenced, as appropriate, in subsequent discussions of impacts for Alternatives B, C, D, and E. The potentially greater magnitude and geographic extent of impacts on aquatic resources because of the substantially greater number of CBM wells that would be developed under Alternatives B, C, D, and E are discussed under those alternatives.

Impacts from Management Common to All Alternatives

Types of impacts on aquatic resources, including fish, aquatic invertebrates, and their habitat, potentially resulting from CBM development activities would be similar to those described for oil and gas exploration and development activities (MBOGC 1989). These include direct removal of habitat, habitat degradation from sedimentation, altered spawning and seasonal migration because of stream obstructions, direct loss of fish from accidental spills or pipeline ruptures releasing harmful substances, increased legal harvests of fish because of increased human access, and reduced stream flows because of removing water for drilling activities. These potential types of impacts are common to all alternatives and are described further under Alternative A (the No Action Alternative). An additional impact on aquatic resources that would only occur under Alternatives A, C, D, and E is the potential for altered stream water quality and/or increased flows in those instances when production water is discharged to drainages. This impact also is described under the No Action Alternative. However, no impacts would result from conventional oil and gas activities because of protection of reservoirs on 1,844 acres.

Impacts from Management Specific to Each Alternative

Alternative A—No Action (Existing CBM Management)

Numerous irrigation-related or naturally occurring dewatering problems that affect aquatic resources have been identified for drainages in the Billings RMP and Powder River RMP areas that would continue under the No Action Alternative. These problems were described in discussions of the affected environment and are not CBM-related. In the Billings RMP area, these include periodic dewatering of portions of the Yellowstone River and downstream sections of the Clarks Fork and Bighorn rivers, and chronic dewatering of the Boulder River, the upstream section of the Clarks Fork, portions of the Musselshell River, and Careless Creek. In the Powder River RMP area, dewatering problems include periodic dewatering of the downstream section of the Tongue River and chronic dewatering of the Powder River. Dewatering indicates a reduction in streamflow, usually during the irrigation season (July through September), beyond the point where stream habitat is adequate for fish. Periodic dewatering indicates a crucial problem in drought or water-short years, and chronic dewatering indicates a critical problem in virtually all years (Montana NRIS 2001).

The two most common forms of water quality effects in the Billings RMP and Powder River RMP area drainages are from elevated sediment and salinity concentrations, primarily from non-point sources related to agricultural practices (MBOGC 1989).

Levels of dissolved solids in drainages tend to increase proceeding downstream because of contributions from irrigation return flows, increased base flows that have been in contact with soil and rocks for long periods of time, and effects of human activities. Water quality in intermittent and ephemeral drainages often is of poor quality because of the sudden and highly variable nature of discharge (snowmelt, intense rainstorms) that would result in elevated turbidity, dissolved solids, and suspended sediment levels in these and in downstream perennial drainages (MBOGC 1989). These water quality conditions would likely continue under the No Action Alternative.

Fish populations and habitat in perennial and intermittent streams in the Billings RMP and Powder River RMP areas are impacted by drought, high temperatures, prolonged cold, heavy icing, and flooding (BLM 1995). Pond habitat and fisheries in the RMP areas also would be affected by dry, low-water years when excessive water temperatures and reduced dissolved oxygen levels during summer would kill fish, and by extended periods of ice and snow and subsequent oxygen depletion during winter that would kill fish (BLM 1995). Water quality and habitat for fish in the Park, Gallatin, and Blaine counties' drainages that were discussed in Chapter 3 generally tend to be good to excellent, primarily because of the proximity to headwaters and/or the often undeveloped or remote nature of the surrounding areas. All of these resource conditions would probably continue under the No Action Alternative.

Previous studies have summarized the ways in which aquatic resources, including fish, aquatic invertebrates, and their habitat, would potentially be impacted, either directly or indirectly, by CBM activities (BLM 1992, USDI 2000, Regele and Stark 2000). Many of these impacts are the same as described for oil and gas exploration and development activities (MBOGC 1989). They include the following effects:

- Loss of aquatic and riparian habitat at stream crossings and near well sites
- Habitat degradation and loss from increased sediment delivery and sedimentation
- Altered spawning and seasonal migrations of fish because of stream obstructions
- Direct loss of fish and aquatic invertebrates from accidental spills, leakage, and runoff of harmful substances into drainages
- Increased legal and possibly illegal harvests of fish because of increased human presence
- Altered water quality and increased stream flows from discharging CBM production water into nearby drainages

Crossing streams and placing facilities such as culverts, bridges, and cattle guards during the construction or upgrading of access roads to well sites would result in the localized loss of aquatic and riparian habitat. Depending on stream location and hydrology, drainages may provide year-round (perennial) or seasonal (intermittent or ephemeral) habitat for a variety of fish species and their life stages, including spawning, incubating, rearing, holding, and over-wintering. Drainages also provide habitat for aquatic macro- and micro-invertebrates that are typically important fish foods, such as aquatic insects, zooplankton, clams, snails, and worms, as well as habitat for aquatic plants, including periphyton, phytoplankton, and vascular macrophytes. Instream activities also would alter habitat characteristics such as water depth, velocity, and habitat types that are important to native and introduced fish species as well as benthic invertebrates.

The loss of riparian habitat would be especially important in smaller drainages because of its many influences on the quality of aquatic habitat. Murphy and Meehan (1991) reported that riparian habitat can form a protective canopy that provides overhead cover for fish and moderates the extreme effects of air temperatures during summer (helps to cool streams) and winter (helps to insulate streams). Riparian habitat also helps reduce soil erosion and filters sediment before it enters streams, stabilizes streambanks, and allows for the formation of undercut banks that provide cover for fish. In addition, riparian habitat contributes litter (nutrients and food for invertebrates) and woody debris (instream cover) to drainages, and it provides habitat for insects that fall to the water's surface and are consumed by fish (Murphy and Meehan 1991). The loss of these riparian functions would result in impacts on aquatic resources.

Soil disturbance, erosion, and runoff during CBM activities would result in increased sediment delivery to streams and the degradation or loss of aquatic habitat. Examples of such activities include the construction, upgrading, use, maintenance, and retirement of access roads; the installation of culverts, bridges, and cattle guards at stream crossings; other instream activities such as fording streams; site preparation, well drilling, and related onsite facilities; and the construction and placement of pipelines for gas delivery. The potential for erosion and runoff would be greatest where wet or moist soils on steep slopes with little or no vegetative cover have been compacted by heavy equipment (BLM 1992).

Increased sediment delivery to drainages would affect aquatic resources through the sedimentation of habitat and increased levels of turbidity and suspended sediment in the water column. Increased sedimentation would cause a reduction or elimination of stream bottom habitat used by aquatic insects such as caddisflies, mayflies, and stoneflies; a subsequent reduction in aquatic insect abundance and diversity; a reduction in the permeability among interstitial spaces within spawning gravels that inhibits the flow of well-oxygenated water and the removal of metabolic wastes; a subsequent reduction in spawning success, hatching success, and fish production; and a reduction in the interchange of surface and subsurface waters in the hyporheic (mixing) zone beneath the stream channel (Nelson et al. 1991, USDI 2000). Substantially increased sedimentation would eliminate or reduce the depths of pools that provide important year-round cover for juvenile, sub-adult, and adult fish, and would cause the premature siltation of beaver ponds, which often provide year-round habitat for trout (MBOGC 1989). If severe enough, increased sediment loads would cause the erosion and migration of stream channels (Chamberlin et al. 1991), and the degradation of aquatic and riparian habitat.

Elevated turbidity and suspended sediment levels caused by increased sediment delivery would have sublethal and acute effects on fish. Nelson et al. (1991) reported that suspended sediment concentrations of 1,200 mg/l can cause mortalities in under yearling salmonids, while suspended sediment concentrations as low as 100 mg/l up to 1,000 mg/l are sometimes associated with a general reduction in fish activity, impaired feeding, reduced growth, downstream displacement, and decreased resistance to other environmental stressors. MBOGC (1989) reported fish and fish food production would be affected by the abrasive effects of very fine sediment on fish embryos and fry and on immature aquatic insects. In addition, very turbid waters would exhibit increased temperatures because of the water's capacity to retain more heat. This would affect those fish and invertebrate species with the most restrictive cold-water or cool-water thermal requirements.

The most severe aquatic impacts resulting from increased sediment delivery would be to trout, whitefish, and grayling. These species have relatively narrow habitat requirements, including the need for clean, cold, well-oxygenated water and/or gravels for spawning, egg incubation, rearing, and adult success (Bjornn and Reiser 1991). The MBOGC (1989) generally concluded that in Montana, increased sediment delivery would have a greater impact on aquatic resources in high-gradient mountain streams than in low-gradient prairie streams. Mountain streams typically support the very sensitive and highly valued species of salmonids, which are generally much less tolerant of increased sediment and turbidity levels than are the warm water fish species found in the lower-gradient prairie streams and rivers in Montana. The MBOGC (1989) also noted that the potential for impacts from sediment delivery to drainages may be greatest in mountainous terrain because roads and pipelines are typically constructed close to streams where slopes are less steep.

Fish spawning migrations and localized movements would be affected in the event of improper placement, misalignment, or construction of culverts and bridges. Improperly designed facilities would block fish passage directly or constrain fish movements by creating hydraulic barriers caused by excessive water velocities or insufficient water depths. Furniss et al. (1991) reported that unless properly designed, stream crossings would be considered dams that are designed to fail, with subsequent impacts on fish passage and the sedimentation of habitat. Four aspects of culvert design, including diameter, length, slope, and vertical drop to the water's surface, can potentially affect fish passage, especially of smaller fish. The MBOGC (1989) reported that perched culverts or small-diameter culverts with high water velocities effectively block trout spawning migrations. Bell (1986) stated that improperly designed culverts may preclude the passage of small fish and possibly discourage larger fish from attempting passage.

Accidental spills, leakage, and runoff or leaching of petroleum products, drilling fluids stored in reserve pits, and other potentially harmful substances such as CBM production water (discussed further below) to surface water drainages may have acute and chronic effects on fish and their foods (BLM 1992; USDI 2000). These effects are influenced by the nature of the substance including its persistence and fate, volume of spill, distance from surface water and likelihood of entry, the volume and diluting ability of the receiving water, and sensitivity of organisms exposed to the substance. Direct effects can include mortalities of aquatic organisms, while indirect effects may be exhibited through chemically induced changes in densities and community structures of aquatic organisms (Norris et al. 1991). Examples include alteration of environmental characteristics such as cover, food, or some other variable important to the well-being of fishes. Effects would be comparatively greater during low-flow than high-flow periods and in smaller rather than larger water bodies. The MBOGC (1989) concluded that the potential for impacts from accidental spills may be greatest in headwater

mountain streams with relatively low flows because soils in such areas are often porous and runoff to streams is direct and rapid.

Increased human access because of new roads and increased human activity associated with CBM exploration and production may result in increased legal and illegal harvest of fish from nearby drainages (MBOGC 1989). Besides angling mortalities of game species, legal fishing activities may result in the trampling of eggs and recently emerged fry from wading in streams, and walking on or next to streambanks may cause increased bank erosion and habitat sedimentation.

As discussed in the *Hydrological Resources* section, surface water bodies should not be impacted directly from groundwater withdrawal due to the depth and confined nature of the individual coal seams. In the unlikely event that there is a very localized connection between a spring-fed stream and groundwater withdrawals, examples of resultant habitat modifications that could impact fish and invertebrates include reduced water depths; slower water velocities; fewer and/or shallower pools and riffles; increased water temperatures during summer; exposed stream channel bottom and stream banks; reduced habitat for spawning, rearing, holding, and refugia; reduced riparian habitat quantity, quality, and function; and reduced fish and invertebrate production.

Several examples illustrate the potential effects, or in the case of the proposed project, the anticipated absence of effects, of groundwater withdrawals on surface water hydrology and aquatic resources. The *Southern Ute DEIS* (USDI 2000) noted the potential for decreased surface water flows because of CBM production water withdrawals from groundwater aquifers on the Southern Ute Indian Reservation in New Mexico and Colorado. That analysis estimated that between 1,600 and 2,500 acre-feet of water may be lost from instream flows, and concluded that this was not anticipated to impact fish habitat. This is equivalent to a 2.2 to 3.5 cfs reduction in instream flows spread evenly over a year. Under other circumstances and depending on the size of the drainage potentially affected, a flow reduction of about 3 cfs would have substantive effects on very small perennial and intermittent drainages, but negligible effects on very large perennial drainages. Studies also were conducted for the Deer Creek Coal Bed Methane Project, which is in the Tongue River watershed in the northwestern part of the Powder River Basin (BLM 2000a). Hydrologic analysis of the Deer Creek Project, like the hydrologic analysis in this EIS, indicated that because of the sealing effect of the overlying aquitards, water levels in shallow aquifer zones and in shallow wells in the project area would not be impacted by water level drawdowns caused by CBM well operations (BLM 2000a). The Deer Creek analysis concluded that flows and aquatic habitat in project area drainages should not be depleted or aquatic habitat degraded. Similar findings were presented for studies of the Castle Rock Project, which concluded that cumulative impacts on the surface water resources of the exploration area, which include the Powder River and Pumpkin Creek, are expected to be minimal to nonexistent in the short term (BLM 2000b).

Aquatic resources would be affected by the discharge to surface waters of groundwaters that are withdrawn during CBM production activities. The discharge of groundwaters would alter surface water quality and increase flows, impacting aquatic habitat and biota. The effects of production water discharge would be most evident in smaller drainages during low-flow times of the year, particularly in those drainages with low levels of TDS. The specific ionic constituents comprising TDS are also important determinants of a water body's effect on aquatic organisms. For purposes of comparison, fresh water usually has a salinity of less than 500 mg/l while sea water has an average salinity of 35,000 mg/l. The surface discharge and runoff of production water also would cause erosion of soils and even higher concentrations of solids. For the proposed Deer Creek Project in the Tongue River watershed, TDS values of water produced from CBM wells are expected to range from 2,500 to 3,500 mg/l (BLM 2000a). Examples of TDS concentrations in groundwater found in coal aquifers of the Powder River Basin were presented previously in the *Hydrological Resources* section of this document, and ranged from 401 to 2,646 mg/l.

Based on the mitigation measures and assumptions described earlier, relatively few impacts on aquatic resources would be expected from exploration activities at 400 CBM wells on BLM-administered lands under Alternative A. However, short-term impacts on aquatic resources resulting from CBM exploration activities on BLM-administered lands would include increased sediment delivery to nearby drainages during runoff events. Fish passage would also be impeded if culverts or bridges are used to cross drainages and are inappropriately placed. In addition, there is the potential for the accidental spill or leakage and entry of petroleum products into drainages associated with vehicles using the access roads and present at exploration sites. Increased access and human presence during exploration activities also may result in some increased harvest of game fish. There would be no anticipated change in streamflow volumes by exploration activities since these activities would

not discharge production waters into surface drainages. Any untreated waters from exploration would be placed in holding pits, tanks, or reservoirs, with no discharge to waters of the United States allowed.

As noted in the earlier discussion of wildlife resources, nearly all of the mitigation measures for CBM activities on BLM lands do not apply to CBM activities on non-BLM lands (i.e., lands subject to state regulations). Therefore, the absence of mitigation measures that prohibit the occupancy or use of water bodies, floodplains, and riparian areas on lands subject to state regulations increases the likelihood that exploration activities at 275 CBM wells on state-regulated lands within or immediately adjacent to these habitats would have a greater potential for impacting aquatic resources than on BLM-managed lands. These impacts would be in addition to those described in the preceding text for exploration activities on BLM lands. However, the magnitude of these impacts would probably still be minor because of the somewhat limited nature of exploration activities. There would continue to be the potential for increased sediment delivery, possible impedance of fish movements in streams, potential for accidental spills of petroleum products, and possibly increased fish harvest. However, there would be no effect on stream flow volume. In addition, as noted for exploration activities on BLM lands, there would be requirements for placing untreated exploration water in holding pits, tanks, or reservoirs, with no discharge to waters of the United States allowed.

The State of Montana has stressed the importance of protecting high-value recreational fish populations that occur in drainages in the CBM-emphasis area. It is expected that the state would not allow exploration activities to be conducted in a manner that would impact these highly valued fisheries. They include trout fisheries and populations of other important species of game fish, particularly in those drainages in each county that have been judged by the State of Montana to support a resource of national renown and to have outstanding, high, or substantial fisheries resource values.

Under the No Action Alternative, CBM production would only occur on the CX Ranch, where there are no specific mitigation measures for CBM production activities. Because of this, potential impacts from the development of 250 producing CBM wells on the CX Ranch would generally include the same impacts that were described for exploration activities on lands subject to state regulations, although they would extend over a longer period of time. Discharge of production water from these wells would be regulated by the Montana DEQ via a MPDES permit, which would allow 1,600 gallons per minute (gpm) discharge into the upper Tongue River from up to 11 discharge points.

The TDS concentration in CBM-produced water from the CX Ranch is about 1,400 mg/l, while Regele and Stark (2000) reported the average TDS concentration for the Tongue River is 284 mg/l. The resultant TDS concentration from discharging 3.6 cfs (approximately 1,600 gpm) of production water (1,400 mg/l TDS) to the Tongue River with a flow of 39 cfs (284 mg/l TDS) would be 378 mg/l TDS. This represents a 94 mg/l increase in TDS over background levels, but it is still well below the TDS guideline of 1,000 mg/l associated with possible effects on fish. Resultant water temperatures would likely be similar to that of the Tongue River upstream of the mixing zone because of the predominance of river flow. This would not be the case when there is very low or sometimes no background flow in the Tongue River, as is the case during critical drought periods. Under the very worst-case conditions, the only flow in the river would theoretically consist of CBM produced water with a TDS concentration of approximately 1,400 mg/l that has been discharged to the river. While this TDS value would exceed the 1,000 mg/l TDS concentration associated with possible effects on aquatic organisms, it would be the only source of water in the drainage and probably provide at least some refuge for aquatic organisms until background flows return. Water temperatures may initially be somewhat cooler than would normally occur during low-flow periods, but they would likely increase proceeding downstream in response to local climatic conditions.

This same type of analysis can be done by evaluating the effect of produced water and the dilution effect of Tongue River water using bioassays and predictive modeling. However, the results of bioassays differ substantially from and show far fewer effects on aquatic organisms than suggested by predictive modeling. The Mount et al. (1997) model would predict that the produced water from the CX Ranch wells would be lethal to 100 percent of fathead minnows. Once the water is discharged to the Tongue River, the dilution would be such that there would be no increase in toxicity to fish in the river. The model would indicate that if there was no or very little dilution of this discharge by either flowing or standing river water, it would be toxic to fish and aquatic invertebrates.

Results of actual whole effluent toxicity (WET) testing using fathead minnows and a cladoceran (water flea), *Ceriodaphnia dubia*, showed far fewer or no mortalities than predictive modeling. A representative sample of effluent from Fidelity Exploration &

Production Company coal bed natural gas wells that discharges to the Tongue River and of Tongue River receiving water collected immediately upstream of the effluent outfall were used in WET testing. Acute toxicity tests (96 hours for fathead minnows and 48 hours for *Ceriodaphnia*) were conducted at Energy Laboratories, Inc. (2001) in Billings Montana, from March 22 through March 26, 2001, in accordance with Region VIII EPA guidelines. Six dilutions were used during WET testing with percent effluent in each dilution at 0 percent (pure receiving water control), 12.5 percent, 25 percent, 50 percent, 75 percent, and 100 percent (pure effluent). The effluent passed the 50 percent mortality test for both species tested, indicating there would be no mortalities at equal parts of effluent (or less) and receiving river water. At effluent levels of 75 and 100 percent, fathead minnow survival after 96 hours was 85 percent and 60 percent, respectively. *Ceriodaphnia* survival after 48 hours at effluent levels of 75 and 100 percent was 95 and 80 percent, respectively (Energy Laboratories, Inc. 2001). These test results generally indicate some mortalities of fish and insects could occur when the volume of effluent constitutes more than 50 percent of the flow in a drainage.

The abandonment of exploratory and producing wells would have few, if any, direct or indirect impacts on aquatic resources. Activities that impact aquatic habitat and biota during CBM exploration and production phases would cease with CBM abandonment. Any associated long-term effects on aquatic resources from these discontinued activities, such as sediment delivery from roads, would gradually subside as disturbed areas are reclaimed.

Special Status Species

The federally endangered pallid sturgeon, two federal candidate species (Montana Arctic grayling, Warm Springs Zaitzevian riffle beetle), and two fish species (sicklefin chub, sturgeon chub) not warranted for federal listing but of significant concern to the U.S. Fish and Wildlife Service are present in portions of the project area. Also present in portions of the project area are eight BLM-sensitive and/or state fish species of special concern, including blue sucker, northern redbelly dace, finescale dace, paddlefish, pearl dace, shorthead sculpin, shortnose gar, westslope cutthroat trout, and Yellowstone cutthroat trout. Distribution of these species was described in Chapter 3 discussions of the affected environment for aquatic resources. Because of their scarcity or narrow habitat niche, these special status species may be somewhat more vulnerable to potential project effects than were described above for all aquatic resources. However, the potential for affecting any of the federally listed, candidate, significant concern, BLM-sensitive, or state species of concern would generally be similar to that described in the preceding text for other aquatic species, and would either be low or absent. For example, all water from exploration activities would be captured in tanks and not discharged to rivers. In addition, conditions of MPDES Permits would provide legally enforceable assurances that water quality, aquatic resources, and the beneficial uses of receiving waters would not be degraded by production water discharges. Some impacts could potentially occur, however, during extreme low or no flow conditions. Release of adequate quality water from production may improve habitat that has been degraded through water withdrawals. The range and type of other potential effects discussed above for aquatic resources also apply to special status species since they are a subset of aquatic resources. Special status species could be minimally affected through construction of stream crossings, erosion generated by construction activities, and effects of other activities discussed above for aquatic resources.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative A. However, regulations mentioned above related to aquatic resources would be under the jurisdiction of Tribal Laws and not state or federal laws. CBM development on the Crow Reservation is expected to be very limited. To the extent that it does occur, potential impacts on aquatic resources would be similar to those described for private lands and would occur on a much smaller scale than on BLM or State lands. If there were no CBM development on Tribal Lands, then there is expected to be minimal impacts on aquatic resources on the reservation. CBM development in Wyoming could impact surface waters on the reservation and could have an effect on aquatic life.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described in general for Alternative A. CBM development on the Northern Cheyenne Reservation is expected to be very limited. To the extent that it does occur, impacts on aquatic resources would be similar to those described for private lands and would occur on a much smaller scale than on BLM or State lands. If there were no CBM development on Tribal Lands, then there is expected to be minimal impacts on aquatic resources on the reservation. CBM development in Wyoming could impact surface waters on the reservation and could have an effect on aquatic life. However, the pending Montana and Wyoming Water Quality Agreement

would preserve the current water quality in the Tongue River and prevent Wyoming operators from discharging poor quality production water into the Tongue River. The Tongue River borders the reservation on the east.

Conclusions

Relatively few residual impacts on aquatic resources, including the special status species, would be expected from exploration activities on BLM-managed lands. Some minor, short-term impacts on aquatic resources on BLM lands may result from increased sediment delivery, possible impedance of fish movements in streams, potential for accidental spills of petroleum products, and possibly increased fish harvest. Residual impacts on aquatic resources from exploration activities on lands subject to state regulations would be similar to these impacts, although possibly slightly greater in magnitude because of the lack of mitigation measures prohibiting surface occupancy or use of water bodies, floodplains, riparian areas, and steep slopes. Expected impacts on aquatic resources on state-regulated lands would still be relatively minor because of the limited nature of exploration activities and their dispersed pattern over a large geographic area. Residual impacts from developing 250 CBM wells on the CX Ranch would include the same potentially minor kinds of impacts that were described for exploration activities on lands subject to state regulations, although they would extend over a longer period of time. The effects of discharging production water from these wells to the upper Tongue River drainage basin would cause river flow to increase from about 39 cfs to 43 cfs and river TDS concentration to increase from 284 mg/l to 378 mg/l. These increases would not be expected to impact aquatic habitat or organisms in the Tongue River. In addition, the conditions of the MPDES Permit would provide legally enforceable assurances that water quality, aquatic resources, and the beneficial uses of receiving waters would not be degraded by production water discharges. Discharges of CBM produced water during extreme drought conditions of no background flow (worst-case conditions) would probably provide some refuge for aquatic organisms, even though TDS concentration would be approximately 1,400 mg/l and water temperatures would initially be cool but increase. There also could be some mortalities of aquatic organisms, as indicated by results of WET testing, under these extreme conditions. The abandonment of CBM wells would have few, if any, direct or indirect residual impacts on aquatic resources. Long-term effects on aquatic resources associated with discontinued activities, such as sediment delivery from roads, would subside as disturbed areas are reclaimed. Agency mitigation measures implemented during abandonment would reduce erosion potential, prevent water quality degradation, facilitate reclamation of disturbed lands, and further reduce the potential for long-term impacts on aquatic resources, including special status species.

Cumulative Impacts

This assessment considers the potential cumulative impacts on aquatic resources resulting from the effects of the No Action Alternative together with the effects from five coal mines, two minerals/metals mines, five existing power plants, four oil and gas refineries, and two manufacturing facilities that are present within the project area. The greatest potential for impacts on aquatic resources from these other projects is probably from coal mines, both through the direct loss of habitat and the degradation of water quality. Surface water quality near coal mines is impacted by increased sediment load because of increased erosion during mining. This is mitigated by the use of sediment settling ponds and the vegetation of overburden and topsoil storage areas. The discharge of groundwater pumped from mine pits also may affect surface water quality and quantity, depending on the quality of groundwater within the mine vicinity and the quantity of groundwater discharged. Aquatic resources associated with nearby springs and surface streams within the area could be impacted by the lowering of water tables from mining activities. In some instances, mining activities impact aquatic resources by diverting streams or drainage areas that are within the area to be mined. Original topography, including stream channels and drainage areas, are restored during mine reclamation activities. Some of these same types of impacts also may occur at minerals/metals mines, but would be less likely to occur at the power plant, oil and gas refinery, and manufacturing sites.

Other possible impacts on aquatic habitat and biota from these projects include sediment delivery from access roads located near drainages, loss of riparian habitat and function along streams, and reduction in water-based recreational activities such as fishing with the loss of aquatic habitat. The nature of effects on aquatic resources from these activities would be similar to those described for potential impacts under the No Action Alternative for CBM development. Most of these impacts would be limited in area given the generally localized nature of these other projects. Their effects are typically mitigated by following standard construction and operating procedures and BMPs and by implementing reclamation activities during or following project construction, operation, and/or abandonment – the same as described for CBM development under the proposed project. For these

reasons, the effects from these other projects would not be expected to result in substantive cumulative impacts on aquatic resources potentially affected by CBM development.

Regele and Stark (2000) discussed some of the possible biological issues associated with CBM gas development in Montana, including the effects of pumping and discharging production water from CBM wells into surface drainages. They reported that much of the groundwater being produced from more than 3,000 CBM-producing wells in the Wyoming portion of the Powder River Basin is being discharged into rivers that flow directly into southeastern Montana. These include the Powder and Little Powder rivers and their tributaries. Some potential short-term and long-term CBM developmental effects identified by Regele and Stark (2000) include decreased surface water availability in some areas because of groundwater pumping; increased surface water flows in areas receiving CBM discharges in other areas; and water quality effects of CBM development discharges on waters and biota receiving the CBM discharges. However, Wyoming EISs and EAs found no decrease in surface water because of aquitards between production coals and surface waters.

The *Hydrological Resources* impact analysis presented in this chapter evaluated the potential cumulative effects of full-scale CBM development and discharge of produced water to the Powder River Basin in Wyoming. That analysis recognized the substantial flow increases and associated hydrologic and water quality impacts that would occur in the Powder, Little Powder, and Tongue rivers in Montana as a result of those discharges. Impacts on aquatic habitat and biota from that magnitude of discharge also would be substantial. The *Hydrological Resources* analysis noted, however, that the Wyoming DEQ and Montana DEQ have pledged to maintain water quality in these three rivers, and that surface water discharge permits limiting the quantity of CBM-produced waters that would be discharged would mitigate impacts from Wyoming CBM on Montana rivers. This action also would mitigate the potential for cumulative impacts on aquatic resources from the effects of Wyoming CBM on Montana rivers.

Alternative B—Emphasize Soil, Water, Air, Vegetation, Wildlife, and Cultural Resources

Most but not all of the same types of impacts on aquatic resources described for CBM activities under Alternative A (No Action Alternative) would occur under Alternative B. These impacts and some of their effects include the direct removal of aquatic and riparian habitat at stream crossings and near well sites, habitat degradation and loss from sedimentation, altered spawning and seasonal migration because of stream obstructions, direct loss of fish and aquatic invertebrates from accidental spills or pipeline ruptures releasing harmful substances and increased harvests of fish because of increased human access. The magnitude and geographic extent of these impacts would potentially be greater under Alternative B than Alternative A because of the activities associated with the development of an estimated 23,850 CBM production wells and 2,650 CBM dry holes. There would be an estimated 7,621 production wells and 847 dry holes on BLM-administered land, 8,849 production wells and 983 dry holes on state-regulated land, 7,200 production wells and 800 dry holes on Tribal land, and 180 production wells and 20 dry holes on U. S. Forest Service-administered land.

Impacts described under the No Action Alternative that are associated with the discharge of production water to drainages and resultant increases in stream flows and elevated levels of TDS and constituents would not occur under Alternative B. There would be a potential for the accidental spill, release, or seepage of production waters temporarily stored in holding ponds or tanks prior to their injection. However, as noted in the *Hydrological Resources* impact analysis, berms around these facilities would be designed to contain and prevent the accidental runoff to nearby drainages of stored production waters, which should minimize the potential for impacting aquatic habitat and resources.

The *Hydrological Resources* impact analysis indicates, based on the estimated groundwater depletions, those watersheds that may experience the greatest CBM development activity. The most active watersheds are projected to be the Little Bighorn and Lower Bighorn, Upper Tongue and Lower Tongue, Little Powder and Middle Powder, Mizpah, and Rosebud, where an estimated 14 to 50 percent of the groundwater resource in the coal seams within a watershed would be depleted after 20 years. Even though few impacts on aquatic resources are projected under Alternative B, data on fish species present, fisheries management policies, and fisheries resource values would be used to identify those watersheds and drainages that are probably most sensitive to the effects of CBM development and should be monitored closely during CBM activities. Based on these fisheries criteria, drainages probably most sensitive to the effects of CBM development are the Lower Bighorn, Upper Tongue, and Little Bighorn. The Lower Bighorn and Upper Tongue are managed as trout fisheries and have

high fisheries resource values, while the Little Bighorn is managed for warm/cool water fish species and trout, and has a moderate fisheries resource value. The Lower Tongue, Little Powder, and Rosebud are probably less sensitive from a fisheries perspective, being managed as non-trout or undesignated fisheries, but they have high to substantial fisheries resource values. The Mizpah is probably the least sensitive of these drainages, being managed as a non-salmonid (warm water) fishery with a moderate to limited fisheries resource value.

Special Status Species

The types of impacts and potential project effects on special status species under Alternative B would generally be similar to those described in the preceding text for aquatic resources under this alternative. Many of these effects also would be similar to those described under Alternative A. However, they would be greater in magnitude and extent because of considerably more production wells, and would primarily result from construction-related activities. No production water would be discharged to drainages under Alternative B and there would be no resultant potential for affecting special status species. The overall likelihood of affecting special status species would probably be low or absent, depending on species distribution. However, as noted for Alternative A, these species may be somewhat more vulnerable than the more commonly-occurring aquatic species because of their limited distribution, low abundance, and/or narrow habitat requirements.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative B. CBM development on the Crow Reservation is expected to comprise a portion of the estimated 7,200 CBM production wells to be developed on Tribal lands. To the extent that it does occur, potential impacts on aquatic resources would be similar to those described for private lands but would probably occur on a somewhat smaller scale than on BLM or State lands. If there were in fact no CBM development on the Crow Reservation, then there are expected to be minimal impacts on aquatic resources on the reservation. Until the Tribe approves CBM development on the reservation, a 2-mile wide buffer zone around the reservation would be enforced under Alternative B to minimize the potential for adjacent CBM development to affect Tribal aquatic resources.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described in general for Alternative B. CBM development on the Northern Cheyenne Reservation is expected to comprise a portion of the estimated 7,200 CBM production wells to be developed on Tribal lands. To the extent that it does occur, impacts on aquatic resources would be similar to those described for private lands but would probably occur on a much smaller scale than on BLM or State lands. If there were no CBM development on the Northern Cheyenne Reservation, then there are expected to be minimal impacts on aquatic resources on the reservation. Until the Tribe approves CBM development on the reservation, a 2-mile wide buffer zone around the reservation would be enforced under Alternative B to minimize the potential for adjacent CBM development to affect Tribal aquatic resources.

Conclusions

The types of residual impacts that would persist for Alternative B are the same as described for Alternative A, with the following two exceptions. Impacts would occur on a far greater scale under Alternative B than Alternative A. Also, no CBM-produced water would be discharged under Alternative B and there would be no potential for resultant residual impacts on aquatic resources, including special status species, from that particular activity.

Cumulative impacts would be the same as described for Alternative A. In addition, the 1-mile-wide buffer around active coal mines under Alternative B would reduce the potential for cumulative groundwater drawdown impacts to result from coal mine projects.

Alternative C—Emphasize CBM Development

Impacts on aquatic resources associated with Alternative C would include all of those CBM-related impacts described for Alternatives A or B, but they would be greater in magnitude. The intensity and geographic extent of CBM exploration, production, and abandonment under Alternative C would be the same as described for Alternative B. However, Alternative C emphasizes CBM exploration and development with minimal restrictions, and it would disturb many more acres (101,000 acres short-term, 69,000 acres long-term) than Alternative B (80,000 acres short-term, 48,000 acres long-term). Alternative C contains the same set of mitigation measures as Alternative B, whose benefits were described earlier and which were listed in Chapter 2. However, unlike

Alternative B, CBM exploration and production water under Alternative C would be discharged, untreated, onto the ground's surface where it would subsequently enter surface water drainages. There would be no requirement for injecting CBM production water into the ground, for treating water prior to its discharge, or for preparing a site-specific water management plan. Discharged CBM water would be available for beneficial uses by industry, landowners, agriculture, and for wildlife if of suitable quality.

The effects of increased TDS concentrations would probably be greater on the more sensitive species of salmonids in headwater mountain streams than on native fish species in prairie streams that have evolved in an environment of naturally higher TDS levels. In addition, sensitive species of salmonids and non-native warm water fish that have not evolved in highly saline water but that now reside in prairie streams also would be at risk. These species may be particularly vulnerable because TDS levels are generally already high in prairie streams, thereby increasing the potential for TDS-related impacts from CBM production.

Regele and Stark (2000) discussed impacts on aquatic resources resulting from CBM effects on drainage hydrology and water quality that would probably have the greatest likelihood of occurring under Alternative C. Potential impacts from reduced surface water availability would probably be limited to the unlikely event of a very localized connection between a spring-fed stream and groundwater withdrawals. This could possibly result in the reduction or loss of springs and flowing reaches of stream channels that provide habitat for native flora and fauna in southeastern Montana. Regele and Stark (2000) cited studies by the MFWP that recognized the importance of perennial and intermittent prairie streams in the life history of native fishes, by providing spawning and rearing habitat for mainstem fish species. The effects of increased flows from CBM discharges would include channel erosion, soils and vegetation loss, increased sediment load and sedimentation, and degraded water quality; these effects would directly and indirectly impact fish, amphibians, aquatic invertebrates, and algae. Also, if great enough, increased TDS and salinity levels in streams receiving CBM discharges would affect fish and aquatic invertebrates, especially those species not well adapted to high TDS levels, such as salmonids found in higher-elevation streams. Regele and Stark (2000) cited studies that showed TDS concentrations should not be increased above 1,200 micromhos if a water's "excellent biological health characteristics are to be preserved." The potential development of saline seeps down-gradient of CBM holding ponds also would affect aquatic resources present in streams receiving these discharges. Regele and Stark (2000) cited the MFWP, which concluded that because of the limited fisheries habitat available in the arid environment of southeastern Montana, great care must be taken where there is a potential to degrade aquatic resources.

The *Hydrological Resources* impact analysis in this chapter estimated that 0.67 billion cubic feet of CBM water would be discharged to the Montana portion of Powder River Basin drainages each year. This is equivalent to an additional, total year-round basin flow of 21 cfs and assumes a 70 percent conveyance loss prior to discharges reaching drainages. The *Hydrological Resources* impact analysis showed that resultant flow increases over base flows would average less than 1 percent in most of the Powder River Basin drainages. The largest percent base flow changes would occur in the Little Powder and Rosebud drainages, which are managed as non-trout, undesignated fisheries and have high or substantial fisheries resource values. Rosebud Creek has been proposed to be classified as a cold water fishery by the Northern Cheyenne Tribe. It supports northern pike and rainbow trout (FWS 1980). This additional volume of water in Powder River Basin drainages would not be expected to impact larger drainages or their water temperatures, but it would impact smaller perennial, intermittent, and ephemeral drainages, especially if peak discharges of CBM water to smaller drainages greatly exceed this annual average. Water quality would be impacted much more than water quantity from CBM discharges because of the considerably higher TDS and constituent concentrations typically found in CBM-produced water than in surface drainages. The *Wildlife* impact analysis in this chapter notes that the potential for impacting water quality by discharging CBM production water with high salinity and sodicity would be greatest in smaller perennial and intermittent drainages during low-flow periods of the year. The effects of high TDS and constituent concentrations on aquatic organisms were discussed under Alternative A.

The temperature of the smaller perennial, intermittent, and ephemeral receiving water bodies may also be affected by the increased groundwater discharge associated with this alternative. The resultant temperature change and potential for affecting aquatic resources would depend on a number of variables that would have to be determined on a site-specific basis, such as volume and temperature of production and receiving water, time of year, species present and their thermal tolerances, and life history considerations. In the event of reduced water temperatures in receiving waters, any resultant adverse effects would tend to be

greater in those systems or portions of systems (for example, downstream reaches) dominated by species with warm water thermal preferences.

Surface discharges of CBM-produced water would be subject to Montana DEQ MPDES Permit requirements and limitations for discharge into identified watersheds. The volume of CBM production water potentially discharged to the Powder River Basin drainages in Montana that were listed in the *Hydrological Resources* impact analysis has a greater potential for causing sediment, flow, and water quality-related impacts on aquatic resources than the effects of Alternatives A or B. However, these effects would be within the range of acceptable limitations stipulated under the various MPDES Permits that would have to be issued under Alternative C. For this alternative to be viable, conditions of the MPDES Permits must be able to provide legally enforceable assurances that water quality, aquatic resources, and the beneficial uses of receiving waters would not be degraded by production water discharges.

Special Status Species

The types of impacts and potential project effects on federally listed, candidate, significant concern, BLM-sensitive, and state species of concern under Alternative C would generally be similar to those described in the preceding text for aquatic resources under this alternative. Special status species would potentially be affected by changes in the quantity and quality of receiving waters from discharges of CBM-production water, construction of stream crossings, erosion generated by construction activities, and effects of other activities discussed above for aquatic resources. Since production water would not be held in tanks or improved in quality, that which reaches the Tongue, Little Powder, and Powder Rivers would likely have increased SAR values that could affect the quantity and quality of receiving waters, especially during low or no flow conditions, as well as food sources for special status species. One special status species possibly present in downstream reaches of several of these drainages and found in the Yellowstone River within the Powder River RMA that is potentially at risk is the federally-listed, endangered pallid sturgeon. Other special status species occupying similar habitat types in these particular waters also may be at risk. There also is the potential for affecting the two federal candidate species (Montana Arctic grayling and the Warm Springs zaitzevian riffle beetle) because of the nature of CBM exploration and development activities that would occur under Alternative C. However, the likelihood of risk is probably low because grayling are generally found at relatively high, cold headwater locations in the Gallatin River and the Clarks Fork within the project area, and the riffle beetle is found in a single warm spring near the City of Bozeman. Minimizing or avoiding activities in these specific areas to the extent possible would minimize the potential for affecting these candidate species.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative C. CBM development on the Crow Reservation is expected to comprise a portion of the estimated 7,200 CBM production wells to be developed on Tribal lands. To the extent that it does occur, potential impacts on aquatic resources would be similar to those described for private lands but would probably occur on a somewhat smaller scale than on BLM or State lands. If there were in fact no CBM development on Tribal Lands, then there are expected to be minimal impacts on aquatic resources on the reservation. Unlike Alternative B, there would be no restrictive buffer zone around the reservation under Alternative C.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described in general for Alternative C. CBM development on the Northern Cheyenne Reservation is expected to comprise a portion of the estimated 7,200 CBM production wells to be developed on Tribal lands. To the extent that it does occur, impacts on aquatic resources would be similar to those described for private lands but would probably occur on a somewhat smaller scale than on BLM or State lands. Unlike Alternative B, there would be no restrictive buffer zone around the reservation under Alternative C.

Conclusions

The types of residual impacts that would persist for Alternative C are the same as described for Alternative A, but they would occur on a far greater scale. In addition, a large volume of CBM-produced water would be discharged under Alternative C and there would be a potential for resultant residual impacts on aquatic habitat and organisms, including special status species, from that particular activity. One of the most noteworthy potential effects of this alternative on special status aquatic species would be possible risks to the endangered pallid sturgeon.

Cumulative impacts would be the same as described for Alternative A. Unlike Alternative B, there would be no buffers around active coal mines or Indian

reservations to minimize the potential for inter-related effects.

Alternative D—Encourage Exploration and Development While Maintaining Existing Land Uses

Impacts on aquatic resources associated with Alternative D would include all of those CBM-related impacts described for Alternatives A and/or B, but they would be greater in magnitude. The intensity and geographic extent of CBM exploration, production, and abandonment and the acres of land disturbed in the short-term and long-term under Alternative D would be the same as described for Alternative B. However, Alternative D encourages CBM development while maintaining existing land uses and protecting downstream water consumers. Alternative D, like Alternative B, contains the same set of mitigation measures designed to avoid, minimize, or mitigate the impacts of CBM development activities on aquatic resources. However, unlike Alternative B, CBM-produced water (depending on water quality) would be treated, prior to its discharge or storage in holding facilities, so that the effluent meets standards established by the Montana DEQ for downstream uses. Beneficial uses of produced water would be allowed and treatment would vary based on industrial, municipal, agricultural, and wildlife uses. Treated, produced water would be discharged to drainages by pipeline or constructed watercourses to avoid the potential for erosion and sediment-related impacts on aquatic resources. The treatment of produced water prior to its discharge to surface drainages through constructed facilities would greatly reduce the potential for elevated TDS, salinity, and sodicity levels described for Alternative C.

The *Hydrological Resources* impact analysis estimated that 2.24 billion cubic feet of CBM water would enter the Montana portion of Powder River Basin drainages each year. This is equivalent to an additional, total year-round basin flow of 71 cfs and assumes no conveyance losses because of the use of pipelines or constructed water courses to convey discharges. The *Hydrological Resources* impact analysis showed that resultant flow increases over base flows would average 1 percent in Powder River Basin drainages. The greatest increase in base flows (approximately by a factor of 4) would occur in the Little Powder and Rosebud drainages, which would impact aquatic habitat and organisms through the same mechanisms described under Alternative A. This volume of water would not be expected to impact larger drainages, but it would impact other smaller perennial, intermittent, and ephemeral drainages, especially if peak discharges of CBM water to smaller drainages greatly exceed this annual average. There would also be a potential for adverse temperature-related effects on warm water fish species if there is a reduction in receiving water temperature in these smaller drainages. Otherwise, water quality of these streams would not be impacted by discharged water since it would have been treated. As noted for Alternatives A, B, and C, conditions of the MPDES permits issued under Alternative D must be able to provide legally enforceable assurances that water quality, aquatic resources, and the beneficial uses of receiving waters would not be degraded by production water discharges.

Special Status Species

The types of impacts and potential project effects on special status species under Alternative D would generally be similar to those described in the preceding text for aquatic resources under this alternative. Many of these effects also would be similar to those described under Alternatives A and B, except they could be greater in magnitude because of the discharge of treated production water to drainages under Alternative D. Special status species potentially most vulnerable to project-related effects would include those in smaller perennial and intermittent drainages within the Powder River Basin. The overall likelihood of affecting special status species would probably be low or absent, depending on species distribution. However, as noted for the other alternatives, special status species may be somewhat more vulnerable than the more commonly-occurring aquatic species because of their limited distribution, low abundance, and/or narrow habitat requirements.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative D. CBM development on the Crow Reservation is expected to comprise a portion of the estimated 3,600 CBM production wells to be developed on Crow Tribal lands. To the extent that it does occur, potential impacts on aquatic resources would be similar to those described for private lands but would probably occur on a somewhat smaller scale than on BLM or State lands. If there were no CBM development on Tribal Lands, then there are expected to be minimal impacts on aquatic resources on the reservation. Until the Tribe approves CBM development on the reservation, a 2-mile wide buffer zone around the reservation would be enforced under Alternative D to minimize the potential for adjacent CBM development to affect Tribal aquatic resources.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described in general for Alternative D. CBM development on the Northern Cheyenne Reservation is expected to comprise a portion of the estimated 3,600 CBM production wells to be developed on Northern Cheyenne Tribal lands. To the extent that it does occur, impacts on aquatic resources would be similar to those described for private lands but would probably occur on a somewhat smaller scale than on BLM or State lands. If there were no CBM development on Tribal Lands, then there are expected to be minimal impacts on aquatic resources on the reservation. Until the Tribe approves CBM development on the reservation, a 2-mile wide buffer zone around the reservation would be enforced under Alternative D to minimize the potential for adjacent CBM development to affect Tribal aquatic resources.

Conclusions

The types of residual impacts that would persist for Alternative D are the same as described for Alternative A, with the following two exceptions. Impacts would occur on a far greater scale under Alternative D than Alternative A. Also, CBM production water discharged under Alternative D would be treated. Except for possible water temperature changes in smaller drainages, there would be no potential for residual water quality impacts on aquatic resources, including special status species, from that particular activity.

Cumulative impacts would be the same as described for Alternative A. In addition, the 1-mile-wide buffer around active coal mines and the 2-mile-wide buffer around Indian reservations under Alternative D would reduce the potential for cumulative inter-related impacts to occur.

Alternative E—Preferred Alternative

Impacts on aquatic resources associated with Alternative E (the Preferred Alternative) would generally be comparable to the CBM-related impacts described for Alternative B, which emphasizes the protection of natural and cultural resources. The number of CBM wells developed would be the same as under Alternative B although more land would be disturbed under Alternative E in the short-term (99,000 acres) and the long-term (59,000 acres).The objective of Alternative E is to manage CBM development in an environmentally sound manner while sustaining existing land uses. To meet this objective, Alternative E contains requirements designed to protect hydrologic resources by combining management options of CBM-produced water so that no degradation of water quality, including thermal criteria, would be allowed in any watershed. These options include, but are not limited to, industrial, municipal, agricultural, and wildlife beneficial uses, as well as injection, treatment, impoundment, and discharge of CBM water. CBM operators would be required to develop a Water Management Plan as part of their overall Project Plan that describes how impacts on surface resources resulting from exploration and production activities would be minimized or mitigated, and how a discharge (if proposed by the operator) could occur without damaging the watershed-in accordance with a required and approved MPDES Permit and MDEQ water quality laws. The Project Plan would be prepared in consultation with the affected Indian tribes, affected surface owners, and other involved permitting agencies according to guidelines to be developed by the BLM and State of Montana. The lack of transportation corridor requirements under Alternative E would result in greater surface disturbances and possibly increased sediment delivery to nearby drainages compared to Alternative B. However, because of the overall beneficial effect of protective measures, including the mitigation measures described earlier, relatively few impacts on aquatic resources would be expected under Alternative E. Aquatic resources in the same watersheds and drainages identified under Alternative B as being most sensitive to CBM development also should be monitored closely during CBM activities under Alternative E.

Special Status Species

The types of impacts and potential project effects on special status species under Alternative E (the Preferred Alternative) would generally be similar to those described in the preceding text for aquatic resources under this alternative. Requirements designed to protect hydrologic resources by combining management options of CBM-produced water so that no degradation of water quality would be allowed in any watershed would benefit special status species. The lack of transportation corridor requirements under this alternative would result in comparatively greater surface disturbances than under Alternative B and possibly increased sediment delivery to nearby drainages. However, because of the overall beneficial effect of protective measures, relatively few impacts on special status species would be expected under Alternative E. The same watersheds and drainages identified under Alternative B as being most sensitive to CBM development also should be monitored closely during CBM activities under Alternative E.

Crow Reservation

Impacts on the Crow Reservation would be similar to those described in general for Alternative E. CBM development on the Crow Reservation is expected to comprise a portion of the estimated 3,600 CBM production wells to be developed on Crow Tribal lands. To the extent that it does occur, potential impacts on aquatic resources would be similar to those described for private lands but would probably occur on a somewhat smaller scale than on BLM or State lands. If there were no CBM development on Tribal Lands, then there are expected to be minimal impacts on aquatic resources on the reservation. To determine potential impacts to the Crow Reservation from CBM development on lands adjacent to the reservation, monitoring wells would be installed during the exploration phase on all BLM-administered oil and gas estates that adjoin reservation boundaries in Montana. If monitoring indicates drawdown would occur on the reservation, mitigation such as the operator providing a hydrologic barrier, communitization agreement, or spacing that would protect Indian minerals from drainage, would be required.

Northern Cheyenne Reservation

Impacts on the Northern Cheyenne Reservation would be similar to those described in general for Alternative E. CBM development on the Northern Cheyenne Reservation could reach as high as an estimated 3,600 CBM production wells. To the extent that it does occur, potential impacts on aquatic resources would be similar to those described for private lands but would probably occur on a somewhat smaller scale than on BLM or State lands. If there were no CBM development on Tribal Lands, then there are expected to be minimal impacts on aquatic resources on the reservation. The same monitoring and mitigation procedures that were described for the Crow Reservation would be used on the Northern Cheyenne Reservation.

Conclusions

The types of residual impacts that would persist for Alternative E are similar to those for Alternative B. These impacts would be essentially the same as described for Alternative A, except that impacts would occur on a far greater scale and there would be no potential for resultant residual impacts on aquatic resources, including special status species, associated with the disposal of CBM-production water.

Cumulative impacts would be the same as described for Alternative A.